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BULLETIN No. 252

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER August 10, 1915

LIFE HISTORY OF THE CODLING MOTH IN MAINE

By

E. H. SIEGLER and F. L. SIMANTON, Entomological Assistants, Deciduous Fruit Insect Investigations

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INTRODUCTION.

A temporary field station of the United States Bureau of Entomology was established at Winthrop, Me., in the spring of 1913, under the direction of Mr. A. L. Quaintance, in charge of deciduous fruit insect investigations. Mr. E. H. Siegler, of the Bureau of Entomology, was assigned to this station for the purpose of studying the life history of the codling moth (*Carpocapsa pomonella* L.) under Maine conditions. Owing to the transfer of Mr. Siegler in 1914 to another station, Mr. F. L. Simanton was detailed to complete the investigations. The records of the observations, herewith reported, cover the seasons of 1913 and 1914, during part of which time the writers were assisted by Mr. E. R. Van Leeuwen.

In order to ascertain the variations in the life history of the codling moth under diverse climatic conditions, investigations have now been completed in widely separated districts, such as Maine and New Mexico, as well as in representative intermediate localities. The methods of study have been essentially the same wherever the work has been undertaken. In this bulletin a detailed account of the life history of the codling moth is reported as well as brief mention of the means of control.

DEFINITION OF TERMS.

The following terms and definitions have been adopted for this report.

The term brood is used for any stage of any generation of the insect. Thus, first-brood larva refers to a larva of the first generation; spring-brood larva has reference to a larva of either the first or second generation.

Generation is used to include all of the stages of the insect, from the egg to the adult stage.

The life cycle of a generation herein recorded includes the time from the deposition of the egg until the emergence of the moth.

The complete life cycle includes the time from the deposition of the egg of one generation to the deposition of the egg of the next generation.

The term wintering larvæ has reference to the larvæ which winter in the larval stage. It includes all larvæ which do not transform during the same season as hatched.

The wintering larvæ transform in the spring to pupæ, known as spring-brood pupæ (spring pupæ). These in turn transform to spring-brood moths (spring moths). The spring pupæ and spring moths, although the first to appear in the calendar year, are not designated as first-brood pupæ and first-brood moths. The first-brood pupæ and the first-brood moths appear later in the season and are the pupæ and moths of the first generation. These may be conveniently designated summer pupæ and summer moths.

The terms used for Maine conditions are defined as follows:

Wintering larvæ: Include overwintering larvæ of the first and second broods.

Spring-brood pupæ: Include the pupæ from the overwintering larvæ.

Spring-brood moths: Include the moths from the spring pupæ.

The first generation includes:

1. The first brood of eggs.
2. The first brood of larvæ, which includes
    (a) transforming larvæ;
    (b) overwintering larvæ.
3. The first brood of pupæ, or summer pupæ.
4. The first brood of moths, or summer moths.

The second generation (not complete in Maine) includes:

1. The second brood of eggs.
2. The second brood of larvæ. None of these larvæ transform until the following spring.

SEASONAL-HISTORY STUDIES OF 1913.

The codling-moth life-history investigations were conducted under outdoor conditions, so that the results obtained would represent, as nearly as possible, the normal life of this insect in the field. Accordingly the rearing work was carried on in an open shelter erected for this purpose.

As a basis of comparison the laboratory methods were checked with field observations chiefly by means of banded trees. The apple trees were prepared for banding by removing the loose bark from the trunk and main limbs. A burlap band of three thicknesses and about 5 inches in width was then placed tightly around the trunk about 3 feet above the base and held in place by an 8-penny wire nail. The larvæ were collected from these banded trees every three days. These larvæ hatched and fed under natural conditions, and hence their time of leaving the fruit and their subsequent life history should correspond with those of the larvæ reared by the laboratory methods.

The general method for carrying out the life-history studies is illustrated in Plate II, figure 1. The cages used were large glass battery jars covered with cheesecloth tops, which were held in place by rubber bands. In cage *a* (Pl. II, fig. 1) are shown the racks in which the codling-moth larvæ have spun their cocoons. The details of these racks are illustrated in Plate II, figure 2, and described on page 4. Pupation is recorded daily and after the moths emerge the length of the pupal stage is computed. The moths are transferred daily from cages similar to cage *a* (Pl. II, fig. 1), and confined within cages like cage *b* (Pl. II, fig. 1). The bottom of cage *b* is covered with 3 inches of moist sand and contains fresh apple foliage and a sponge moistened with a sugar solution. The moths deposit their eggs upon the foliage, which is removed each day and the number of eggs recorded. The following data are obtained from cage *b*: (1) Days before egg deposition; (2) time of egg deposition; (3) length of oviposition period; (4) total number of eggs; (5) average number of eggs per female; (6) length of life of male and female moths.

In order to prevent curling, the leaves are placed between two pieces of wire screen until the leaves dry—cage *c* (Pl. II, fig. 1). They are then removed from cage *c* to cage *d* (Pl. II, fig. 1), in which cage the embryological changes and incubation periods are noted. Upon hatching the larvæ are transferred to cage *e* (Pl. II, fig. 1). This cage contains apples placed within a wire container and also the racks in which the larvæ spin their cocoons.

Since the time of entering the fruit is known and since the time of leaving is found by a daily examination of the cocoon racks, the length of the feeding period is thus established. By following the successive stages of the codling moth through the series of five cages the life cycle is readily ascertained.

It should be explained here that each table is a unit in itself. Successive tables are not necessarily continuations of the life history of all of the same individuals. For example, it will be noted that Table I is a record of the time of pupation of 753 wintering larvæ and that Table II includes observations on the length of the pupal stage of but 483 of these individuals. Differences of this character may be due to natural or artificial causes, such as to death, to accidental injury, to parasites, to the removal of specimens for other purposes, and to accidental escape of the moths during examination.

WINTERING LARVÆ.

The wintering larvæ, as stated in the definition of terms, comprise first and second brood larvæ. These larvæ winter naturally in cocoons (Pl. I, fig. 1), usually beneath the loose bark of trees, in decayed wood, or in other similarly protected places on or about the tree. The larvæ are inactive until spring, when they remodel their cocoons, so as to furnish exit tubes for the moths. (See Pl. I, fig. 2.) The exit tube, which varies in length according to the exigency, assists the moth in successfully emerging from the cocoon.

The codling-moth larvæ used at the laboratory were collected early in the spring of 1913. These larvæ were secured from cider mills where they had spun up beneath the flooring and in other concealed places. The larvæ were then allowed to form new cocoons in racks such as are shown in the illustration (Pl. II, fig. 2).

These racks consist of two strips of soft wood, to the lower of which three narrow crosspieces are glued—one at each end and one in the middle. A thin piece of mica is then placed between these crosspieces and the top strip and the whole is held together by two clamps. This makes it possible to remove the top strip and to observe the specimens through the mica. Referring to the illustration, it will be seen that there are artificial cells or compartments. The walls of these were first outlined with a little glue over which sawdust was sprinkled. Although more than one larva frequently spins up within the same chamber the artificial barriers serve to keep the larvæ somewhat separated. Such separation facilitates the recording of the observations.

SPRING BROOD OF PUPÆ.

Time of pupation.—Daily observations of the wintering larvæ were taken and as each larva pupated its number was recorded upon the rack directly below the pupa. (Pl. II, fig. 2.) In Table I is shown

4

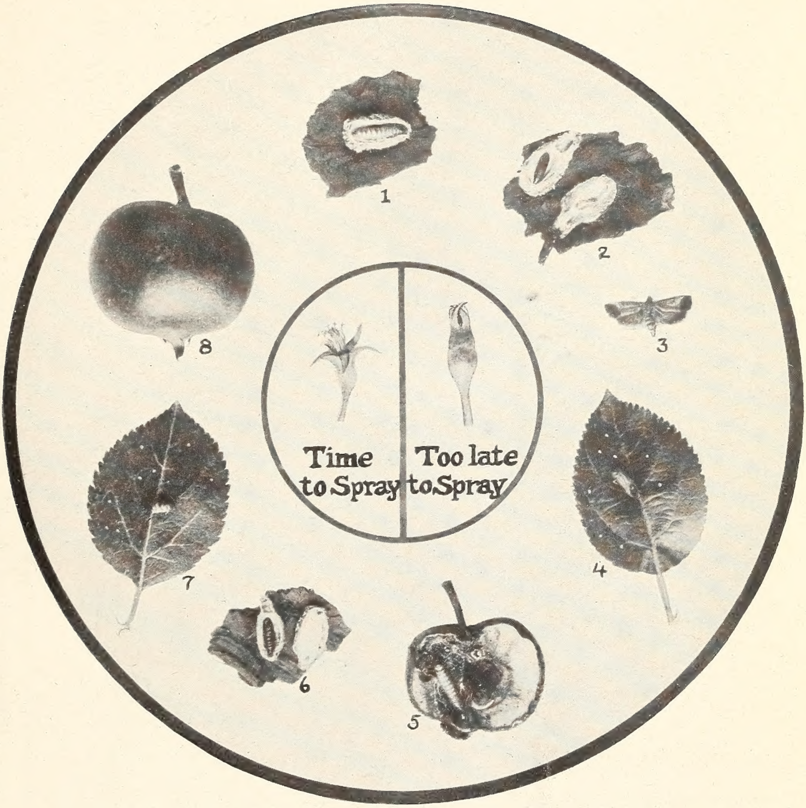
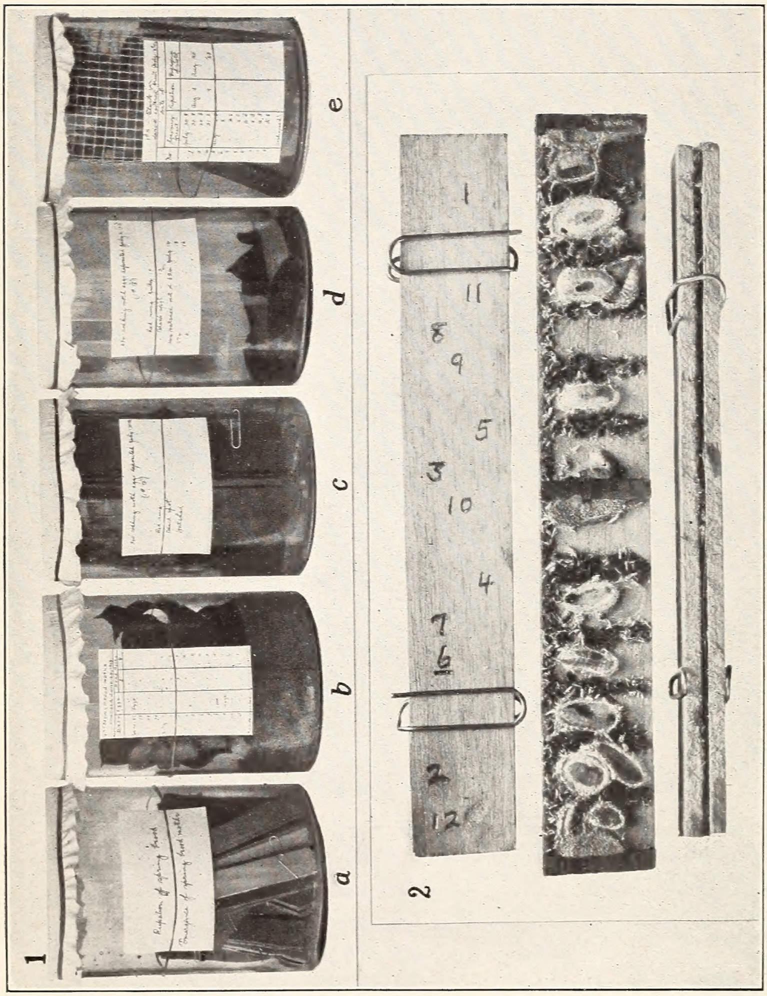


CHART ILLUSTRATING THE LIFE HISTORY OF THE CODLING MOTH IN MAINE.

FIG. 1.—Overwintering larva in cocoon. FIG. 2.—Cocoons remodeled by overwintering larvæ to form exit tubes. The upper cocoon contains a spring-brood pupa; the lower, a pupal skin from which the moth emerged. FIG. 3.—A spring-brood moth. FIG. 4.—A spring-brood moth ovipositing on leaf, showing first-brood eggs. FIG. 5.—A wormy apple containing a first-brood larva. FIG. 6.—Cocoons of first-brood larvæ, one of which transformed to pupa. FIG. 7.—First-brood moth ovipositing on leaf, showing second-brood eggs. FIG. 8.—An apple showing where a second-brood larva entered the side. Time to spray, as soon as petals drop. Too late to spray, calyx cup closed. (Original.)



APPARATUS EMPLOYED IN THE REARING OF THE CODLING MOTH IN MAINE.

FIG. 1.—*a*, Pupation and moth emergence cage; *b*, oviposition cage; *c*, leaf-pressing cage; *d*, incubation cage; *e*, feeding cage. FIG. 2.—Cocooning rack (three views) in which the larvæ spin their cocoons and pupate. (Original.)

the time of pupation of 753 overwintering larvæ. It will be noted that the first larva pupated May 5, while the last larva under observation did not pupate until July 7. Hence spring-brood pupation extended over a period of about two months. The maximum time of pupation was June 6, when 72 larvæ transformed. The greater part of the larvæ pupated during the first half of June. (See fig. 1.)

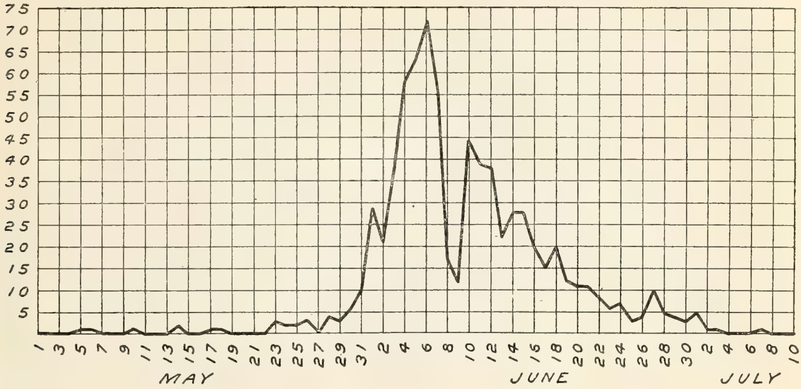


FIG. 1.—Diagram showing pupation of the spring brood of the codling moth in 1913 at Winthrop, Me. (Original.)

TABLE I.—*Time of pupation of overwintering larvæ, Winthrop, Me., 1913.*

Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.
May 5	1	May 31	10	June 13	22	June 26	4
May 6	1	June 1	29	June 14	28	June 27	10
May 10	1	June 2	21	June 15	28	June 28	5
May 14	2	June 3	38	June 16	20	June 29	4
May 17	1	June 4	58	June 17	15	June 30	3
May 18	1	June 5	63	June 18	20	July 1	5
May 23	3	June 6	72	June 19	12	July 2	1
May 24	2	June 7	56	June 20	11	July 3	1
May 25	2	June 8	17	June 21	11	July 7	1
May 26	3	June 9	12	June 22	9		
May 28	4	June 10	44	June 23	6	Total..	753
May 29	3	June 11	39	June 24	7		
May 30	6	June 12	38	June 25	3		

Length of the pupal stage.—The average length of the pupal stage of 483 individuals, as recorded in Table II, was found to be 19.03 days; maximum, 44 days; minimum, 9 days. By reference to this table it will be seen that as the season advanced the length of the pupal stage was gradually shortened, due to higher average daily temperatures.

TABLE II.—*Length of the pupal stage of spring-brood pupæ, Winthrop, Me., 1913.*

Number of individuals.	Date of pupation.	Length of the pupal stage in specified days.																						
		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	31	
1	May 17																							1
2	May 25																2							
2	May 26																			2				
1	May 28															1								
2	May 29														2									
2	May 30														2									
4	May 31													1	3									
16	June 1												2	8	4	2								
8	June 2												1	3	2	2								
18	June 3												3	5	9							1		
37	June 4											1	2	17	10	4			1	1		1		
42	June 5											1	8	11	19				1		1		1	
47	June 6												3	36	4	2		1		1				
35	June 7									1	1	1	12	11	8					1				
13	June 8											2	4	6	1									
10	June 9											2	6	1	1									
18	June 10						1			2	1	10	4											
26	June 11									2	4	13	5		1							1		
27	June 12							1		1	9	16												
17	June 13								1	1	13	1	1											
22	June 14									12	9	1												
21	June 15		1							15	4	1												
16	June 16								1	4	8	1			2									
12	June 17								3	9														
16	June 18						1	4	8		3													
8	June 19							2	4	2														
10	June 20					2	2	2	2	2														
9	June 21			1				6	2															
5	June 22							4				1												
5	June 23						3	1		1														
3	June 24						1	1	1															
3	June 25					2				1														
4	June 26				1		2					1												
8	June 27		1			1	2	4																
3	June 28	1			1			1																
4	June 29						3		1															
1	June 30							1																
3	July 1						1			1	1													
1	July 3									1														
1	July 7					1																		
483 pupæ....		1	2	1	2	6	16	27	23	55	53	52	51	99	68	11	2	1	2	5	1	3	1	1

Average length of the pupal stage, 19.03 days.
Maximum length of the pupal stage, 44 days.
Minimum length of the pupal stage, 9 days.

SPRING BROOD OF MOTHS.

Time of emergence of moths.—The first of the spring-brood moths emerged June 18, about two weeks after the petals dropped. The maximum emergence of moths occurred June 27—one month after full bloom. The last of the spring-brood moths issued July 20. The emergence record of 514 moths is given in Table III.

TABLE III.—*Time of emergence of moths of the spring brood, Winthrop, Me., 1913. (See fig. 2.)*

Date of emergence.	Number of moths.	Date of emergence.	Number of moths.	Date of emergence.	Number of moths.	Date of emergence.	Number of moths.
June 18	2	June 27	74	July 5	10	July 15	4
June 20	5	June 28	27	July 6	14	July 18	1
June 21	10	June 29	39	July 7	14	July 0	2
June 22	15	June 30	32	July 8	5		
June 23	14	July 1	50	July 10	7	Total.	514
June 24	25	July 2	35	July 11	3		
June 25	43	July 3	16	July 12	4		
June 26	25	July 4	34	July 13	4		

Time of egg deposition.—As will be seen in Table IV, the first eggs of the spring-brood moths were laid on June 22, while the last oviposition occurred July 30. Hence the period of oviposition was approximately 1 month. The average number of days from the time of emergence to the time of first oviposition was 4.086 days; maximum, 14 days; minimum, 1 day. The average duration of the oviposition period was 14.086 days; maximum, 26 days; minimum, 1 day. The average number of days from the date of moth emergence to the last date of oviposition was 16.739 days; maximum, 27 days; minimum, 6 days.

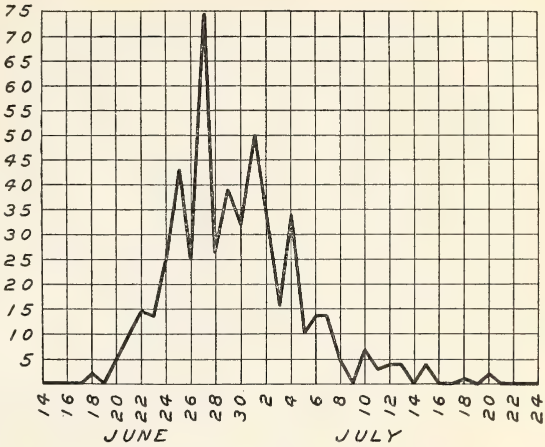


FIG. 2.—Diagram showing emergence of the spring brood of moths of the codling moth in 1913 at Winthrop, Me. (Original.)

TABLE IV.—*Oviposition by moths of the spring brood in rearing cages, Winthrop, Me., 1913.*

Cage No.	Number of moths.	Sex.		Date of—			Number of days—		
		♂	♀	Emergence of moths.	First oviposition.	Last oviposition.	Before oviposition.	Of oviposition.	From date of emergence to last oviposition.
1	2 5 10	9	8	June 18 June 20 June 21	June 22	July 7	....	....	....
2	13	9	4	June 22	June 29	July 2	7	4	10
3	13	9	4	June 23	...do....	July 3	6	5	10
4	19	12	7	June 24	...do....	July 9	5	11	15
5	41	16	25	June 25	June 27	...do....	2	13	14
6	24	13	11	June 26	July 3	July 8	7	6	12
7	30	16	14	June 27	June 29	July 14	2	16	17
8	38	12	26	...do....	...do....	July 24	2	26	27
9	24	11	13	June 28	July 1	July 13	3	13	15
10	26	8	18	June 29	...do....	July 22	2	22	23
11	25	14	11	June 30	July 2	July 23	2	22	23
12	25	10	15	July 1	July 3	July 27	2	25	26
13	18	7	11	...do....	...do....	July 22	2	20	21
14	31	16	15	July 2	July 4	...do....	2	19	20
15	14	5	9	July 3	July 5	July 23	2	19	20
16	28	15	13	July 4	...do....	July 22	1	18	18
17	9	6	3	July 5	July 6	...do....	1	17	17
18	13	3	10	July 6	July 8	July 30	2	23	24
19	11	4	7	July 7	July 11	July 29	4	19	22
20	5	3	2	July 8	July 18	July 20	10	3	12
21	5	1	4	July 10	July 17	July 25	7	9	15
22	4	2	2	July 12	July 15	July 20	3	6	8
23	3	1	2	July 13	July 17	July 23	14	7	10
24	4	2	2	July 15	July 21	July 21	6	1	6
Number of male moths.......... 204					Average..........		4.086	14.086	16.739
Number of female moths........ 236					Maximum..........		14	26	27
Total number of moths.......... 440					Minimum..........		1	1	6

Number of eggs per female.—No attempt was made to isolate fertilized females for the purpose of securing individual egg-laying records. However, by dividing the number of eggs laid by the number of female moths the average was computed. In Table IV it will be seen that 236 female moths were confined with 204 males in 24 cages. A few eggs were laid upon the sides of the cages, but these were not included in the computation. The number of eggs, exclusive of those laid upon glass, was 7,546, which number when divided by 236 gives an average of 31.974 eggs per female.

Length of life of moths.—Observations on the length of the life of 191 male moths and 229 female moths are shown in Table V. The average life of the male moth was 10.685 days; of the female, 12.253 days. Maximum number of days for male moth 34, for female 38; minimum number of days for male moth 2, for female 2.

TABLE V.—*Length of life of male and female moths of the spring brood in captivity; summary of records of 420 individual moths, Winthrop, Me., 1913.*

Male.		Female.		Male.		Female.	
Length of life.	Number of moths.	Length of life.	Number of moths.	Length of life.	Number of moths.	Length of life.	Number of moths.
Days.		*Days*		*Days.*		*Days.*	
2	3	2	1	22	2	22	1
3	7	3	5	23	2	23	5
4	5	4	4	24	0	24	3
5	15	5	12	25	1	25	2
6	15	6	11	26	0	26	1
7	20	7	18	27	2	27	1
8	22	8	13	28	0	28	2
9	24	9	24	29	0	29	2
10	13	10	20	30	1	30	0
11	5	11	20	31	2	31	0
12	7	12	15	32	0	32	2
13	6	13	3	33	0	33	0
14	9	14	19	34	2	34	0
15	5	15	10	35	0	35	0
16	6	16	9	36	0	36	0
17	4	17	6	37	0	37	0
18	1	18	5	38	0	38	1
19	5	19	3				
20	4	20	7		191		229
21	3	21	4				

Average length of life of male moths, 10.685 days; female moths, 12.253 days.
Maximum length of life of male moths, 34 days; female moths, 38 days.
Minimum length of life of male moths, 2 days; female moths, 2 days.

THE FIRST GENERATION.

FIRST BROOD OF EGGS.

Length of incubation.—During the period of oviposition a record of 7,546 eggs was kept. Of this number 7,493 (99.29 per cent) hatched. The average number of days from the time of oviposition to the appearance of the red ring was 2.507; maximum, 5 days; minimum, 2 days. The average time elapsing from the time of oviposition to the appearance of the black spot was 5.580 days; maximum, 7 days; minimum, 4 days. The average incubation period was 8.874 days; maximum, 10 days; minimum, 6 days. The results are given in Table VI.

TABLE VI.—*Length of incubation of first brood of eggs, Winthrop, Me., 1913.*

No. of observation.	Number of eggs.	Date—				Appearance of—		Incubation period.	Number dead.
		Deposited.	Red ring.	Black spot.	Hatched.	Red ring.	Black spot.		
						Days.	*Days.*	*Days.*	
1		June 22	June 26	June 29	July 1	4	7	9	
2	1	June 24	June 27	...do	...do	3	5	7	
3	1	...do			July 2			8	
4	11	June 26	June 28	July 1	July 3	2	5	7	
5	1	...do			July 4			8	
6	10	June 27	June 29	July 2	July 3	2	5	6	
7	61	...do			July 4			7	1
8	80	June 28	July 1	July 3	...do	3	5	6	
9	37	...do			July 5			7	
10	165	June 29	July 2	July 4	...do	3	5	6	
11	40	...do			July 6			7	
12	108	June 30	July 3	July 5	...do	3	5	6	
13	10	...do			July 7			7	
14	504	July 1	July 3	July 5	...do	2	4	6	
15	31	...do			July 8			7	
16	25	...do			July 9			8	
17	65	July 2	July 4	July 6	July 8	2	4	6	
18	730	...do			July 9			7	
19	20	...do			July 10			8	
20	716	July 3	July 5	July 7	...do	2	4	7	
21	46	...do			July 11			8	19
22	27	July 4	July 7	July 10	...do	3	6	7	
23	725	...do			July 12			8	
24	15	...do			July 13			9	4
25	1,040	July 5	July 8	July 12	...do	3	7	8	
26	21	...do			July 14			9	5
27	344	July 6	July 10	July 13	...do	4	7	8	
28	274	...do			July 15			9	
29	19	...do			July 16			10	3
30	47	July 7	July 10	July 13	July 15	3	6	8	
31	9	...do			July 16			9	
32	1	...do			July 17			10	
33	153	July 8	July 10	July 14	July 16	2	6	8	
34	220	...do			July 17			9	
35	169	July 9	July 11	July 15	...do	2	6	8	
36	17	...do			July 18			9	5
37	21	July 10	July 12	July 15	...do	2	5	8	
38	4	...do			July 19			9	
39	326	July 11	July 13	July 16	...do	2	5	8	
40	5	...do			July 20			9	
41	414	July 12	July 14	July 18	...do	2	6	8	
42	17	...do			July 21			9	6
43	123	July 13	July 15	July 19	July 20	2	6	7	
44	47	...do			July 21			8	
45	9	...do			July 22			9	1
46	59	July 14	July 17	July 20	...do	3	6	8	
47	2	...do			July 23			9	1
48	54	July 15	July 17	July 21	July 22	2	6	7	
49	64	...do			July 23			8	
50	173	July 16	July 18	July 22	...do	2	6	7	
51	22	...do			July 24			8	2
52	25	July 17	July 22	July 23	...do	5	6	7	
53	129	...do			July 25			8	
54	9	July 18	July 22	July 23	...do	4	5	7	
55	15	...do			July 26			8	1
56	10	July 19	July 22	July 24	July 25	3	5	6	
57	38	...do			July 26			7	
58	50	July 20	July 23	July 25	July 27	3	5	7	
59	6	...do			July 28			8	
60	35	July 21	July 24	July 27	...do	3	6	7	
61	11	...do			July 29			8	2
62	40	July 22	July 25	July 27	...do	3	5	7	
63	7	...do			July 30			8	
64	20	July 23	July 26	July 29	...do	3	6	7	2
65	20	July 24	...do	July 30	July 31	2	6	7	
66	14	July 25	July 27	...do	Aug. 1	2	5	7	
67	1	...do			Aug. 2			8	
68	8	July 26	July 28	Aug. 1	...do	2	6	7	
69	2	...do			Aug. 3			8	1
70	6	July 27	July 29	Aug. 2	...do	2	6	7	
71	3	...do			Aug. 4			8	
72	6	July 28	July 30	Aug. 2	...do	2	5	7	
73	4	July 29	July 31	Aug. 4	Aug. 5	2	6	7	
74	3	...do			Aug. 6			8	
75	1	Aug. 1	Aug. 4	Aug. 7	Aug. 9	3	6	8	
Average						2.507	5.580	8.874	53
Maximum						5	7	10	
Minimum						2	4	6	

FIRST BROOD OF LARVÆ.

Time of hatching.—The earliest first-brood larvæ hatched July 1; the latest hatched August 9. Hence larvæ of the first brood were hatching for a period of over one month. The larvæ were hatching in large numbers from July 7 to July 15, reaching the maximum on July 13, at which time 1,055 larvæ hatched. These records appear in Table VI.

Length of the feeding period of the transforming larvæ.—Three methods for determining the feeding period of the first-brood larvæ were used:

(*A*) *Stock-jar method.* The newly hatched larvæ were allowed to enter fruit known to be free from codling-moth infestation. This fruit was placed in cages similar to cage *e* (Pl. II, fig. 1). As each larva left the fruit its number was recorded upon the cocooning rack directly beneath the cocoon made by the larva. Since the time of entering the fruit was known, the length of the feeding period was thus established.

(*B*) *Watered stock-jar method.* This method was similar to (*A*), except that twigs having two or three apples were placed for a period of two weeks in glass jars containing water. The apples were then pulled and kept under conditions identical with (*A*).

(*C*) *Bagged-fruit method.* Newly hatched larvæ were placed on fruit growing on the tree and the fruit was then covered with perforated paper bags. After a period of two weeks the fruit was removed to the laboratory and kept under conditions identical with (*A*).

In 1913 the number of transforming larvæ reared at the laboratory was 3.8 per cent of the first brood. All larvæ which do not transform during the same season as hatched winter as larvæ and pupate the following spring and are designated spring pupæ.

In Table VII the length of the feeding period of the transforming larvæ of the first brood (stock-jar method) is given. The average number of days of feeding (male and female larvæ) was 20.454; male larvæ, 22.333; female larvæ, 20.200; maximum feeding period, male, 24 days; female, 24 days; minimum feeding period, male, 21 days; female, 17 days.

TABLE VII.—*Length of feeding period of transforming larvæ of the first brood, stock-jar method, Winthrop, Me., 1913.*

No. of observation.	Date of—		Sex of larva.	Days of feeding.	No. of observation.	Date of—		Sex of larva.	Days of feeding.
	Hatching.	Leaving fruit.				Hatching.	Leaving fruit.		
	July 6	July 30	♂	24	7	July 7	July 31	♀	24
2	July 7	July 25	....	18	8	July 10	July 30	♀	20
3	July 7	July 26	....	19	9	July 10	July 31	♀	21
4	July 7	July 27	....	20	10	July 15	Aug. 3	♀	19
5	July 7	July 28	♂	21	11	July 19	Aug. 5	♀	17
6	July 7	July 29	♂	22					

Average length of feeding period, male and female larvæ, 20.454 days; male, 22.333 days; female, 20.20 days.

Maximum length of feeding period, male and female larvæ, 24 days; male, 24 days; female, 24 days.

Minimum length of feeding period, male and female larvæ, 17 days; male, 21 days; female 17 days.

Table VIII gives a record of the feeding period of the transforming larvæ of the first brood (watered stock-jar method). The average feeding period for male and female larvæ was 24.769 days; for male larvæ, 23 days; female larvæ, 25.142 days; maximum, male, 27 days; female, 31 days; minimum, male, 21 days; female, 20 days.

TABLE VIII.—*Length of feeding period of transforming larvæ of the first brood, watered stock-jar method, Winthrop, Me., 1913.*

No. of observation.	Date of—		Sex of larva.	Days of feeding.	No. of observation.	Date of—		Sex of larva.	Days of feeding.
	Hatching.	Leaving fruit.				Hatching.	Leaving fruit.		
1	July 7	July 29	♂	22	8	July 11	Aug. 3	♀	23
2	July 7	July 30	♂	23	9	July 12	Aug. 2	♂	21
3	July 8	Aug. 2	♀	25	10	July 12	Aug. 3	♂	22
4	July 8	Aug. 3	♀	26	11	July 12	Aug. 7	♀	26
5	July 8	Aug. 8	....	31	12	July 13	Aug. 2	♀	20
6	July 8	Aug. 8	♀	31	13	July 16	Aug. 10	♀	25
7	July 10	Aug. 6	♂	27					

Average length of feeding period, male and female larvæ, 24.769 days; male, 23 days; female, 25.142 days.
Maximum length of feeding period, male and female larvæ, 31 days; male, 27 days; female, 31 days.
Minimum length of feeding period, male and female larvæ, 20 days; male, 21 days; female, 20 days.

As shown in Table IX, the feeding period of the transforming first-brood larvæ (bagged-fruit method) averaged for male and female 25.818 days; for male larvæ, 23.833 days; female larvæ, 29.250 days. The maximum feeding period for male larvæ was 27 days; female, 34 days. The minimum feeding period for male larvæ was 21 days; for female, 26 days.

By reference to Table XIX, it will be noted that the average feeding period of the transforming larvæ was 23.432 days.

TABLE IX.—*Length of feeding period of transforming larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1913.*

No. of observation.	Date of—		Sex of larva.	Days of feeding.	No. of observation.	Date of—		Sex of larva.	Days of feeding.
	Hatching.	Leaving fruit.				Hatching.	Leaving fruit.		
1	July 3	July 27	....	24	7	July 5	Aug. 8	♀	34
2	July 4	July 30	♀	26	8	July 7	July 31	♂	24
3	July 4	July 31	♀	27	9	July 7	July 31	♂	24
4	July 4	July 31	♂	27	10	July 8	July 30	♂	22
5	July 4	Aug. 3	♀	30	11	July 10	July 31	♂	21
6	July 5	July 30	♂	25					

Average length feeding period, male and female larvæ, 25.818 days; male, 23.833 days; female, 29.250 days.
Maximum length feeding period, male and female larvæ, 34 days; male, 27 days; female, 34 days.
Minimum length feeding period, male and female larvæ, 21 days; male, 21 days; female, 26 days.

Length of the feeding period of wintering first-brood larvæ (stock-jar method).—Table X records the feeding period of 390 larvæ. As will be noted, the feeding period for all male and female larvæ averaged

25.925 days; maximum, 49 days; minimum, 16 days. The average feeding period for 140 male larvæ was 24.621 days; maximum, 46 days; minimum, 16 days. The average for 207 female larvæ was 26.371 days; maximum, 44 days; minimum, 19 days. Remainder of larvæ—sex undetermined.

TABLE X.—*Length of feeding period of wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1913.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		16		19		20		21		22		23		24		25		26	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 5														1				
8	July 6											1			3	2			
9	July 7							1			1		1	(1)	1		2		
18	July 8									1	1			2	1	2		2	1
10	July 9									1					2		1		1
39	July 10					1	1					3	4(1)	4	4	1	(1)	2	2
13	July 11										2	1	1			2	1		1
25	July 12								2				1	3		1	3	2	2
13	July 13							2		1		1			2			1	1
13	July 14					2		1		3	1	(1)			1	1	1(1)		1
41	July 15			1	1	3	4	3	2	1	5	3	2	2	3(2)	1	1	(1)	2
6	July 16				1			2			1	(1)							
16	July 17										2		2	3			1		
22	July 19			1		4	1	3	3(1)		1	2	1		1				
28	July 20	1			1				2	1	2	1	4	2(2)	1		2		2
15	July 21							1				2	1	2	1		1		3
12	July 23											(1)	3	3	1			1	
13	July 24										1			3	2	1			2
14	July 25									1									
11	July 26					(1)					2			1	2				
4	July 27																1		1
16	July 28									1	1			1	2	1	1		2
13	July 29					1		2		2		1	(1)	(1)				(2)	1
12	July 30							1		1	1					3		1	
2	July 31																		
2	Aug. 1																		
3	Aug. 3									1					(1)				
2	Aug. 4																		2
5	Aug. 6															(1)	1		
1	Aug. 9														(1)				
390 ♂ and ♀		1	0	2	3	11	6	16	9	14	21	15	20	26	28	15	16	9	24
Sex undetermined						1		1				5		8		3		3	
Total		1		5		18		26		35		40		62		34		36	

TABLE X.—*Length of feeding period of wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		27		28		29		30		31		32		33		34		35	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 5	....	1	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....	....
8	July 6	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....
9	July 7	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
18	July 8	....	....	3	1(2)	....	....	....	....	....	....	....	....	2	....	....	....	....	....
10	July 9	2	1(1)	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
39	July 10	....	1	....	3	1	1	(1)	4	....	....	1	....	....	....	....	1	....	....
13	July 11	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....	2	....	....
25	July 12	(1)	1	1	4	....	....	....	....	....	....	....	....	....	....	....	2	(1)	....
13	July 13	....	1	....	....	....	....	....	....	1	(1)	....	....	....	....	....	2	....	....
13	July 14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
41	July 15	....	....	....	....	....	1	....	....	....	1	....	....	....	....	....	1	....	....
6	July 16	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....
16	July 17	....	....	1(1)	2	....	....	....	2	....	1	....	....	....	....	....	1	....	....
22	July 19	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....	1	(1)	....
28	July 20	....	2	1	....	....	....	....	2	1	....	....	....	....	....	....	....	(1)	....
15	July 21	(1)	1	(1)	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....
12	July 23	....	1	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....
13	July 24	....	....	....	....	....	1	....	....	1	....	....	....	....	....	....	1	....	1
14	July 25	....	....	3	4	....	....	1	1	....	....	1	....	....	1	....	....	....	....
11	July 26	....	....	....	....	....	....	....	1	1	1	....	....	....	....	....	....	....	1
4	July 27	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16	July 28	....	....	....	....	....	2	....	....	....	2	....	....	1	....	....	1	....	....
13	July 29	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	July 30	....	....	....	1	....	1	....	....	....	....	....	....	....	1	....	....	....	....
2	July 31	....	....	....	....	(1)	....	....	....	....	....	(1)	....	....	....	....	....	....	....
2	Aug. 1	....	....	....	....	....	....	....	1	....	....	....	(1)	....	....	....	....	....	....
3	Aug. 3	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Aug. 4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Aug. 6	....	....	....	....	....	1	....	....	....	(1)	....	....	(1)	....	....	....	....	....
1	Aug. 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
390 ♂ and ♀		3	10	11	15	2	8	2	13	4	7	3	2	3	4	0	12	0	2
Sex undetermined		3		4		1		1		2		2		1		....		3	
Total		16		30		11		16		13		7		8		12		5	

TABLE X.—*Length of feeding period of wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		36		37		38		39		40		43		44		46	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
8	July 6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9	July 7	....	....	....	....	(1)	....	....	....	....	....	....	....	....	....	....	....
18	July 8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	July 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
39	July 10	....	....	....	....	(1)	....	....	....	....	....	....	1	....	....	....	....
13	July 11	....	....	(1)	....	....	....	....	....	....	....	....	....	....	....	....	....
25	July 12	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....
13	July 13	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13	July 14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
41	July 15	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
6	July 16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16	July 17	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
22	July 19	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
28	July 20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 21	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	July 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13	July 24	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14	July 25	(1)	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
11	July 26	....	....	....	....	....	....	(1)	....	....	....	....	....	....	....	....	....
4	July 27	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
16	July 28	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
13	July 29	....	....	....	1	....	....	1	....	....	....	....	....	....	....	....	....
12	July 30	....	....	....	....	....	1	....	....	....	....	....	....	....	1	....	....
2	July 31	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Aug. 1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
3	Aug. 3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Aug. 4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Aug. 6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1	Aug. 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
390 ♂ and ♀		0	1	0	3	0	1	1	0	1	0	0	1	0	1	1	0
Sex undetermined		1		1		2		1		....		....		....		....	
Total		2		4		3		2		1		1		1		1	

Average feeding period, 390 male and female larvæ, 25.925 days; 140 male larvæ, 24.621 days; 207 female larvæ, 26.371 days.

Maximum feeding period, 390 male and female larvæ, 49 days; 140 male larvæ, 46 days; 207 female larvae, 44 days.

Minimum feeding period, 390 male and female larvæ, 16 days; 140 male larvæ, 16 days; 207 female larvæ, 19 days.

Length of the feeding period of wintering first-brood larvæ (watered stock-jar method).—As shown in Table XI, the average feeding period of 260 male and female larvæ was 26.569 days; maximum, 41 days; minimum, 19 days. The average for 111 male larvæ was 26.315 days; maximum, 40 days; minimum, 19 days. The average feeding period for 123 female larvæ was 26.463 days; maximum, 41 days; minimum, 20 days. Remainder of larvæ—sex undetermined.

TABLE XI.—*Length of feeding period of wintering larvæ of the first brood, watered stock-jar method, Winthrop, Me., 1913.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		19		20		21		22		23		24		25		26	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17	July 8	....	....	....	....	....	....	....	....	....	....	1	....	....	....	2	(2)
16	July 9	....	....	....	....	....	....	....	....	....	....	....	1	(1)	....	1	1
11	July 10	....	....	....	....	....	....	....	1	....	1	(2)	1	....	....	1	2
13	July 11	....	....	....	....	....	....	2	....	4	4	....	....	....	2	....	....
26	July 12	....	....	....	....	....	....	....	1	(1)	3	....	....	5	1(1)	4	2
10	July 13	....	....	2	....	1	....	....	....	2	1	....	....	1	....	1	1
12	July 14	....	....	....	....	....	....	....	1	(1)	....	(1)	2	....	2	1	2
19	July 15	1	....	2	....	3	1	....	3	1	....	1	1	....	....	1	3
17	July 16	....	....	....	....	1	....	....	1	....	2	2	1	1	....	1	3
18	July 17	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....
9	July 18	....	....	....	....	....	....	....	....	2	....	....	....	1	2	....	1
18	July 20	....	....	....	....	1	....	....	2	....	....	....	2	1	2	....	1
15	July 21	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....
8	July 22	....	....	....	....	....	....	2	2	....	1	....	....	....	....	1	1
15	July 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1
15	July 24	....	....	....	....	....	....	....	....	....	....	....	1	....	1	6	1
7	July 25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	4
7	July 26	....	....	....	....	....	....	....	1	....	1	....	....	1	....	1	....
3	July 27	....	....	....	....	....	....	1	....	1	....	....	....	1	....	....	....
260 ♂ and ♀		1	0	4	0	6	1	8	12	10	14	5	9	11	10	22	23
Sex undetermined		....		....		....		....		2		3		2		2	
Total		1		4		7		20		26		17		23		47	

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.													
		27		28		29		30		31		32		33	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 7	....	2	....	1	1	....	....	....	....	....	....	....	....	....
17	July 8	....	....	2	1(2)	....	....	1	2	....	....	....	....	1	1
16	July 9	....	2	....	3	....	....	1	2	(1)	....	1	....	....	....
11	July 10	1	1	....	....	....	1	....	....	....	....	....	....	....	....
13	July 11	(1)	....	....	....	....	....	....	....	....	....	....	....	....	....
26	July 12	(1)	2	....	....	(1)	3	....	....	....	....	(1)	....	....	....
10	July 13	....	1	....	....	....	....	....	....	....	....	....	....	....	....
12	July 14	....	1	1	....	....	....	....	....	....	....	....	....	....	....
19	July 15	....	....	....	....	....	....	....	....	....	....	1	....	....	1
17	July 16	....	1	....	1	(1)	1	....	....	1	....	....	....	....	....
18	July 17	1	....	2	....	....	....	3	....	....	2	2	1	1	....
9	July 18	....	....	....	....	1	1	....	....	....	1	....	....	....	....
18	July 20	1	1	....	1	1	1	1	(2)	1	....	....	....	....	....
15	July 21	3(2)	2	....	2	....	....	....	....	....	....	(1)	2	....	....
8	July 22	(1)	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 23	2	2	1	....	1	1	....	....	2	....	....	....	....	....
15	July 24	....	....	2	2(1)	....	....	(1)	....	....	....	....	....	....	....
7	July 25	....	....	....	....	....	1	....	....	....	....	....	1	....	....
7	July 26	....	....	2	....	....	....	....	....	....	1	....	....	....	....
3	July 27	....	....	....	....	....	....	....	....	....	....	....	....	....	....
260 ♂ and ♀		8	15	10	11	4	9	6	4	4	4	4	4	2	2
Sex undetermined		5		3		2		3		1		2		....	
Total		28		24		15		13		9		10		4	

TABLE XI.—*Length of feeding period of wintering larvæ of the first brood, watered stock-jar method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.													
		34		35		36		37		38		40		41	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4	July 7	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17	July 8	....	....	1	....	....	....	....	....	....	1	....	....	....	....
16	July 9	1	....	....	....	....	....	....	....	....	....	1	....	....	....
11	July 10	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13	July 11	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26	July 12	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	July 13	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	July 14	....	....	....	....	....	....	....	....	....	....	....	....	....	....
19	July 15	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17	July 16	....	....	....	....	....	....	....	....	....	....	....	....	....	....
18	July 17	....	....	....	....	....	1	....	1	....	1	....	....	....	1
9	July 18	....	....	....	....	....	....	....	....	....	....	....	....	....	....
18	July 20	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 21	....	....	....	....	....	....	....	....	....	....	....	....	....	....
8	July 22	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 23	2	....	1	....	....	....	....	....	....	....	(1)	....	....	....
15	July 24	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	July 25	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	July 26	....	....	....	....	....	....	....	....	....	....	....	....	....	....
3	July 27	....	....	....	....	....	....	....	....	....	....	....	....	....	....
260 ♂ and ♀		3	....	2	....	....	1	....	1	....	2	1	....	....	1
Sex undetermined		....		....		....		....		....		1		....	
Total		3		2		1		1		2		2		1	

Average length of feeding period, 260 male and female larvæ, 26.569 days; 111 male larvæ, 26.315 days; 123 female larvæ, 26.463 days.

Maximum length of feeding period, 260 male and female larvæ, 41 days; 111 male larvæ, 40 days; 123 female larvæ, 41 days.

Minimum length of feeding period, 260 male and female larvæ, 19 days; 111 male larvæ, 19 days; 123 female larvæ, 20 days.

Length of the feeding period of wintering first-brood larvæ (bagged-fruit method).—Table XII shows that the average feeding period of 236 male and female larvæ was 32.572 days; maximum, 49 days; minimum, 19 days. The average for 93 male larvæ was 29.182 days; maximum, 49 days; minimum, 24 days. The average for 126 female larvæ was 35.492 days; maximum, 46 days; minimum, 19 days. The sex of the remainder of the larvæ was undetermined.

Table XII.—*Length of feeding period of wintering larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1913.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		19		23		24		25		26		27		28		29		30	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1	July 3	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....
17	July 4	....	....	....	....	....	....	....	....	2	....	....	....	1	....	2	3	1	....
10	July 5	....	....	....	....	....	....	....	....	....	....	1	1	....	....	1	1	....	2
11	July 6	....	....	....	....	....	....	....	....	1	....	1	1	1	....	(1)	2	1	(1)
22	July 7	....	....	....	....	....	....	1	....	6	4	4	1	....	....	(1)	2	2	1
19	July 8	....	....	....	....	....	1	1	....	1	2	....	....	3(2)	3	....	....	....	3
29	July 9	....	....	....	....	1	....	3	3	....	2	1	5	2	3	....	....	(2)	2
15	July 10	....	....	....	1	3	1(1)	1	....	1	1	....	3	....	1	1	....	....	1
12	July 11	....	....	....	....	....	....	....	1	....	....	1	....	....	2	....	2	....	1
10	July 12	....	....	....	....	....	....	....	....	....	1	1	....	....	1	....	....	1	1
24	July 13	....	....	....	....	1	(1)	1	1	2	2(1)	....	1	2	....	4	1(1)	....	....
11	July 14	....	....	....	....	....	....	....	1	1	....	1	1	....	1	....	....	2	....
10	July 15	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....
4	July 16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 17	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	2	....	....
8	July 20	....	1	....	....	....	....	....	....	....	....	....	2	....	1	1	....	....	....
11	July 22	....	....	....	....	....	....	....	2	1	....	2	(1)	....	....	....	....	....	....
7	July 23	....	....	....	....	....	....	1	....	....	....	....	1	....	....	....	1	....	....
236 ♂ and ♀		....	1	0	1	5	2	8	8	15	12	14	16	10	13	9	14	7	11
Sex undetermined		....		....		— 2		....		1		1		2		3		3	
Total		1		1		9		16		28		31		25		26		21	

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		31		32		33		34		35		36		37		39	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1	July 3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17	July 4	....	....	2	....	1	....	1	....	....	....	....	1	....	1	....	....
10	July 5	....	2	....	....	(1)	....	....	....	....	....	....	....	....	....	....	1
11	July 6	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
22	July 7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
19	July 8	1	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....
29	July 9	....	1	3	....	....	....	....	....	....	....	....	....	....	1	....	....
15	July 10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	July 11	....	2	....	2	....	....	....	....	(1)	....	....	....	....	....	....	....
10	July 12	....	....	1	....	....	3	....	....	....	....	....	1	....	....	....	....
24	July 13	....	....	2	....	....	....	1	....	....	1	....	1	....	....	....	....
11	July 14	....	....	1	2	1	....	....	....	....	....	....	....	....	....	....	....
10	July 15	....	1	....	2	....	....	1	1	....	1	....	....	....	1	....	....
4	July 16	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
15	July 17	....	....	1	2	....	....	....	....	....	1	1	3	(1)	....	....	....
8	July 20	....	....	....	1	....	1	....	....	....	....	....	....	1	....	....	....
11	July 22	(2)	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	July 23	1	....	....	....	....	....	....	....	....	2	....	....	....	1	....	....
236 ♂ and ♀		3	9	10	12	2	4	3	1	....	5	1	6	1	4	....	1
Sex undetermined		2		....		1		....		1		....		1		....	
Total		14		22		7		4		6		7		6		1	

TABLE XII.—*Length of feeding period of wintering larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		40		41		42		43		44		46		47		49	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1	July 3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
17	July 4	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....
10	July 5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	July 6	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
22	July 7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
19	July 8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
29	July 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	July 10	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	July 11	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	July 12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
24	July 13	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	July 14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	July 15	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....
4	July 16	....	....	....	1	....	1	....	....	....	....	....	....	....	....	1	....
15	July 17	....	....	....	....	....	....	....	....	....	1	....	1	1	....	....	....
8	July 20	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	July 22	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	July 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
236 ♂ and ♀		1	....	....	2	....	2	2	....	....	1	....	1	1	....	1	....
Sex undetermined		....		....		....		....		....		....		....		....	
Total		1		2		2		2		1		1		1		1	

Average length of feeding period, 236 male and female larvæ, 32.572 days; 93 male larvæ, 29.182 days; 126 female larvæ, 35.492 days.

Maximum length of feeding period, 236 male and female larvæ, 49 days; 93 male larvæ, 49 days; 126 female larvæ, 46 days.

Minimum length of feeding period, 236 male and female larvæ, 19 days; 93 male larvæ, 24 days; 126 female larvæ, 19 days.

It will be noted that the larvæ which transform during the same season as hatched have, upon an average, a shorter feeding period than those which do not transform until the following spring. The average feeding period for 30 transforming larvæ of the first brood was 23.432 days; the average feeding period for 886 wintering larvæ of the first brood was 27.884 days. It will be further noted that in every instance, except one (Table VII), the average feeding period of the female larvæ was longer than that of the male. In the exception cited the result is not considered conclusive, owing to the small number of observations.

Larval life in the cocoon.—The time of making the cocoon is calculated from the time a transforming larva leaves the fruit until it has pupated. The average time consumed in constructing the cocoon was 6.566 days; maximum, 13 days; minimum, 2 days. (See Table XIII.)

TABLE XIII.—*Length of the pupal stage of the first brood, Winthrop, Me., 1913.*

No. of observation.	Date of—			Making of cocoon.	Pupal period.	No. of observation.	Date of—			Making of cocoon.	Pupal period.
	Leaving fruit.	Pupation.	Emergence.				Leaving fruit.	Pupation.	Emergence.		
				Days.	*Days.*					*Days.*	*Days.*
1	July 25	July 30	Aug. 11	5	12	16	July 31	Aug. 6	Aug. 23	6	17
2	July 26	...do....	Aug. 14	4	15	17	...do....	Aug. 8	Aug. 27	8	19
3	July 27	...do....	...do....	3	15	18	...do....	Aug. 9	Aug. 23	9	14
4	...do....	Aug. 1	Aug. 16	5	15	19	Aug. 2	Aug. 8	Aug. 27	6	19
5	July 28	Aug. 3	Aug. 17	6	14	20	...do....	Aug. 9	Aug. 24	7	15
6	July 29	...do....	...do....	5	14	21	Aug. 3	...do....	Aug. 23	6	14
7	...do....	...do....	...do....	5	14	22	...do....	Aug. 10	Aug. 25	7	15
8	July 30	...do....	...do....	4	14	23	...do....	Aug. 11	Aug. 26	8	15
9	...do....	Aug. 4	...do....	5	13	24	...do....	Aug. 15	Aug. 30	12	15
10	...do....	Aug. 5	Aug. 20	6	15	25	...do....	Aug. 16	Sept. 1	13	16
11	...do....	Aug. 7	Aug. 22	8	15	26	Aug. 5	Aug. 11	Aug. 26	6	15
12	...do....	Aug. 9	Aug. 26	10	17	27	Aug. 6	Aug. 13	Aug. 31	7	18
13	July 31	Aug. 4	Aug. 18	4	14	28	Aug. 7	Aug. 14	Aug. 29	7	15
14	...do....	Aug. 5	Aug. 19	5	14	29	Aug. 8	Aug. 10	Aug. 26	2	16
15	...do....	Aug. 6	...do....	6	13	30	Aug. 10	Aug. 22	Sept. 6	12	15
Average										6.566	15.066
Maximum										13	19
Minimum										2	12

FIRST BROOD OF PUPÆ OR SUMMER PUPÆ.

Time of pupation.—The earliest pupation of the first-brood larvæ occurred July 30, the latest August 22. (See Table XIII and fig. 3.)

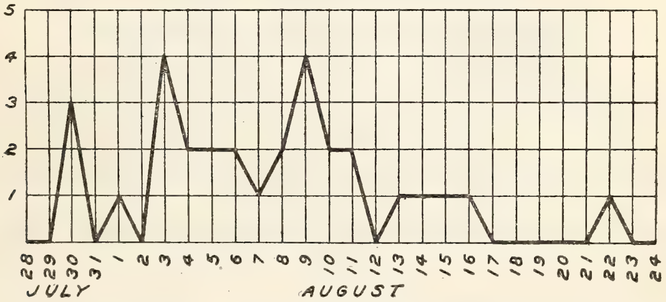


FIG. 3.—Diagram showing pupation of the first brood of the codling moth in 1913 at Winthrop, Me. (Original.)

Length of the pupal stage.—The average length of the first-brood pupal stage, as shown in Table XIII, was 15.066 days; maximum, 19 days; minimum, 12 days.

FIRST OR SUMMER BROOD OF MOTHS.

Time of emergence.—First-brood moth emergence commenced August 7, as shown in Table XIV. The last moth of the summer brood emerged September 6. As previously stated, the number of first-brood larvæ transforming in Maine is comparatively small, and hence the summer brood of moths is small. (See fig. 4.)

TABLE XIV.—*Time of emergence of moths of the first or summer brood, Winthrop, Me., 1913.*

Date of emergence.	Total emergence.
Aug. 7	1
9	3
11	1
13	3
16	1
17	5
18	2
19	2
20	1
Aug. 23	4
24	2
25	1
26	4
27	2
31	2
Sept. 1	1
6	1
	36

Time of oviposition.—The first eggs of the summer-brood moths were deposited August 15, the last were laid September 25. (See Table XV.)

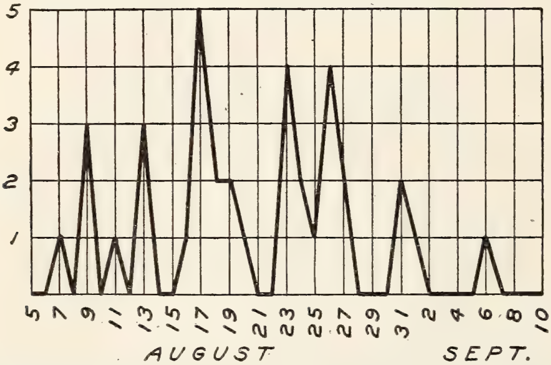


FIG. 4.—Diagram showing emergence of the first brood of moths of the codling moth in 1913 at Winthrop, Me. (Original.)

TABLE XV.—*Time of oviposition of the first or summer brood of moths, Winthrop, Me., 1913.*

CAGE NO. 1.

Date.	Number of moths emerged.	Eggs deposited.	Death of moths.[1]	
			Male.	Female.
Aug. 7	1			
9	3			
11	1			
13	3			
15		Eggs		
16	1	do.		
17		do.		
18		do.		1
Aug. 19		Eggs	1	
20			1	1
25			1	
26			1	1
Sept. 3				1
	9		4	4

[1] One moth escaped from cage No. 1, 2 from cage No. 2.

TABLE XV.—*Time of oviposition of the first or summer brood of moths, Winthrop, Me., 1913*—Continued.

CAGE NO. 2.

Date.	Number of moths emerged.	Eggs deposited.	Death of moths.		Date.	Number of moths emerged.	Eggs deposited.	Death of moths.	
			Male.	Female.				Male.	Female.
Aug. 17	5	....	....	....	Sept. 4	....	Eggs...	2	1
18	2	....	....	....	5	....	...do....	....	....
19	2	....	....	....	6	1	...do....	....	....
20	1	....	....	....	7	....	...do....	....	2
21	....	....	....	....	8	....	...do....	....	....
22	....	Eggs...	....	....	10	....	...do....	....	2
23	4	...do....	....	....	12	....	...do....	....	1
24	2	...do....	....	1	14	....	....	1	1
25	1	...do....	....	....	15	....	Eggs...	....	....
26	4	...do....	....	1	20	....	....	1	....
27	2	...do....	....	....	22	....	Eggs...	....	....
28	....	...do....	....	....	25	....	...do....	....	....
29	....	...do....	....	....	26	....	....	1	....
30	....	...do....	....	2	27	....	....	1	1
31	2	...do....	2	1	28	....	....	1	....
Sept. 1	1	...do....	1	2					
2	....	...do....	....	....		27		10	15
3	....	...do....	....	....					

Number of eggs per first-brood female moth.—This data was obtained by dividing the total number of second-brood eggs (1,013) by the total number of female moths kept in confinement. These figures show that the average number of eggs per female was 53.316.

LENGTH OF LIFE CYCLE OF THE FIRST GENERATION.

In view of the fact that three methods of taking codling-moth feeding records were used, it became necessary to give the life-cycle results in three separate tables—Tables XVI, XVII, and XVIII. These tables include the life cycle of the insect from the time of egg deposition to the emergence of the moth and, as recorded therein, the life cycle according to the stock-jar method was 47.818 days; watered stock-jar method, 53.500 days; bagged-fruit method, 54 days. The complete life cycle extends from the time of the deposition of the egg of one generation to the deposition of the egg of the next generation. Hence, in order to get the number of days for the complete life cycle the time elapsing from the emergence of the moth to the first oviposition—approximately 4 days—should be added to the above figures.

TABLE XVI.—*Life cycle of the first generation of the codling moth, as observed by rearing at Winthrop, Me., 1913, stock-jar feeding method.*

No. of observation.	Date of—					Days for—				
	Egg deposition.	Hatching.	Larva leaving the fruit.	Pupation.	Emergence of moth.	Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
1	June 30	July 6	July 30 ♂ ...	Aug. 7	Aug. 22	6	24	8	15	53
2	July 1	July 7	July 25	July 30	Aug. 11	6	18	5	12	41
3	...do	...do	July 26......	...do	Aug. 14	6	19	4	15	44
4	...do....	...do....	July 27......	Aug. 1	Aug 16	6	20	5	15	46
5	...do....	...do....	July 28 ♂ ...	Aug. 3	Aug. 17	6	21	6	14	47
6	...do....	...do....	July 29 ♂ ...	...do....	...do....	6	22	5	14	47
7	...do....	...do....	July 31 ♀ ...	Aug. 6	Aug. 19	6	24	6	13	49
8	July 3	July 10	July 30 ♀ ...	Aug. 5	Aug. 20	7	20	6	15	48
9	...do....	...do....	July 31 ♀ ...	Aug. 9	Aug. 23	7	21	9	14	51
10	July 7	July 15	Aug. 3 ♀ ...	Aug. 15	Aug. 30	8	19	12	15	54
11	July 11	July 19	Aug. 5 ♀ ..	Aug. 11	Aug. 26	8	17	6	15	46
Average......						6.545	20.454	6.545	14.272	47.818
Maximum......						8	24	12	15	54
Minimum......						6	17	4	12	41

[1] Add 4 days for complete life cycle.

TABLE XVII.—*Life cycle of the first generation of the codling moth, as observed by rearing at Winthrop, Me., 1913, watered stock-jar feeding method.*

No. of observation.	Date of—					Days for—				
	Egg deposition.	Hatching.	Larva leaving the fruit.	Pupation.	Emergence of moth.	Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
1	July 1	July 7	July 29[2]	Aug. 3	Aug. 17	6	22	5	14	47
2	...do....	...do....	July 30[2]	...do....	...do....	6	23	4	14	47
3	July 2	July 8	Aug. 3[3]	Aug. 9	Aug. 23	6	26	6	14	52
4	...do....	...do....	Aug. 8	Aug. 10	Aug. 26	6	31	2	16	55
5	July 3	July 10	Aug. 6[2]	Aug. 13	Aug. 31	7	27	7	18	59
6	July 4	July 11	Aug. 3[3]	Aug. 16	Sept. 1	7	23	13	16	59
7	July 5	July 12	Aug. 2[2]	Aug. 9	Aug. 24	7	21	7	15	50
8	...do....	...do....	Aug. 3[2]	Aug. 10	Aug. 25	7	22	7	15	51
9	...do....	...do....	Aug. 7[3]	Aug. 14	Aug. 29	7	26	7	15	55
10	July 8	July 16	Aug. 10[3]	Aug. 22	Sept. 6	8	25	12	15	60
Average......						6.7	24.6	7	15.2	53.5
Maximum......						8	31	13	18	60
Minimum......						6	21	2	14	47

[1] Add 4 days for complete life cycle. [2] Male. [3] Female.

TABLE XVIII.—*Life cycle of the first generation of the codling moth, as observed by rearing at Winthrop, Me., 1913, bagged-fruit feeding method.*

No. of observation.	Date of—					Days for—				
	Egg deposition.	Hatching.	Larva leaving the fruit.	Pupation.	Emergence of moth.	Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
1	June 26	July 3	July 27	July 30	Aug. 14	7	24	3	15	49
2	June 28	July 4	July 30[2]	Aug. 9	Aug. 26	6	26	10	17	59
3	...do....	...do....	July 31[2]	Aug. 8	Aug. 27	6	27	8	19	60
4	...do....	...do....	...do.[3] ..	Aug. 6	Aug. 23	6	27	6	17	56
5	...do....	...do....	Aug. 3[2]	Aug. 11	Aug. 26	6	30	8	15	59
6	June 29	July 5	July 30[3]	Aug. 4	Aug. 17	6	25	5	13	49
7	...do....	...do....	Aug. 2[2]	Aug. 8	Aug. 27	6	28	6	19	59
8	July 1	July 7	July 31[3]	Aug. 4	Aug. 18	6	24	4	14	48
9	July 3	July 10	...do.[3] ..	Aug. 5	Aug. 19	7	21	5	14	47
Average						6.222	25.777	6.111	15.888	54
Maximum						7	30	10	19	60
Minimum						6	21	3	13	47

[1] Add 4 days for complete life cycle. [2] Male. [3] Female.

As shown in Table XIX, which is a summary of Tables XVI, XVII, and XVIII, the average of the life cycles was 51.566 days. The complete life cycle would be about 55 to 56 days.

TABLE XIX.—*Summary of the life cycle of the first generation of the codling moth, Winthrop, Me., 1913.*

	Number of observations.	Larval feeding method.	Days for—				
			Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
Average life cycle	11	A	6.545	20.454	6.545	14.272	47.818
Do	10	B	6.700	24.600	7.000	15.200	53.500
Do	9	C	6.222	25.777	6.111	15.888	54.000
Average of all life cycles	30	A+B+C	6.499	23.432	6.566	15.066	51.566

[1] Add 4 days for complete life cycle.
A, stock-jar method; B, watered stock-jar method; C, bagged-fruit method.

THE SECOND GENERATION.

SECOND BROOD OF EGGS.

Length of incubation.—Observations on the period of incubation extended from August 15, when the first eggs of the second brood were deposited, until October 15, when the last of the eggs of this brood hatched. A total of 1,013 eggs were laid, of which number 972 (95.9 per cent) hatched. The average incubation period was 11.862 days; maximum, 23 days; minimum, 7 days. The average time for the appearance of the red ring was 2.884 days; maximum, 7 days; minimum, 1 day. The average time for the appearance of the black spot was 9.069 days; maximum, 18 days; minimum, 5 days. The incubation observations are recorded in Table XX.

TABLE XX.—*Length of incubation of second brood of eggs, Winthrop, Me., 1913.*

No. of observation.	Number of eggs.	Date—				Appearance of—		Incubation period.	Number dead.
		Deposited.	Red ring.	Black spot.	Hatched.	Red ring.	Black spot.		
						Days.	*Days.*	*Days.*	
1	10	Aug. 15	Aug. 16	Aug. 21	Aug. 23	1	6	8	2
2	28	Aug. 16	Aug. 17	Aug. 22	Aug. 24	1	6	8	....
3	10	...do....	....	....	Aug. 25	....	....	9	....
4	15	Aug. 17	Aug. 19	Aug. 24	...do....	2	7	8	....
5	48	...do....	....	....	Aug. 26	....	....	9	14
6	17	Aug. 18	Aug. 20	Aug. 25	Aug. 27	2	7	9	....
7	31	...do....	....	....	Aug. 28	....	....	10	....
8	10	...do....	....	....	Aug. 29	....	....	11	2
9	7	Aug. 19	Aug. 22	Aug. 26	...do....	3	7	10	....
10	2	...do....	....	....	Aug. 30	....	....	11	1
11	5	Aug. 22	Aug. 25	Aug. 30	Sept. 1	3	8	10	....
12	86	Aug. 23	....	...do....	...do....	2	7	9	....
13	3	...do....	....	....	Sept. 2	....	....	10	....
14	26	Aug. 24	Aug. 27	Sept. 1	...do....	3	8	9	....
15	8	...do....	....	....	Sept. 3	....	....	10	....
16	1	Aug. 25	Aug. 28	Sept. 1	Sept. 2	3	7	8	....
17	3	...do....	....	....	Sept. 3	....	....	9	....
18	16	Aug. 26	Aug. 29	Sept. 1	...do....	3	6	8	....
19	16	Aug. 27	Aug. 31	Sept. 2	...do....	4	6	7	....
20	42	...do....	....	....	Sept. 4	....	....	8	5
21	36	Aug. 28	Aug. 31	Sept. 3	...do....	3	6	7	....
22	9	...do....	....	....	Sept. 5	....	....	8	1
23	....	....	....	....	....	....	....	....	....
24	5	Aug. 30	Sept. 2	Sept. 4	Sept. 6	3	5	7	....
25	28	...do....	....	....	Sept. 7	....	....	8	....
26	4	...do....	....	....	Sept. 8	....	....	9	....
27	61	Aug. 31	Sept. 3	Sept. 6	...do....	3	6	8	....
28	9	...do....	....	....	Sept. 9	....	....	9	....
29	22	...do....	....	....	Sept. 10	....	....	10	1
30	30	Sept. 1	Sept. 3	Sept. 8	...do....	2	7	9	....
31	15	...do....	....	....	Sept. 11	....	....	10	....
32	12	...do....	....	....	Sept. 12	....	....	11	5
33	31	Sept. 2	Sept. 4	Sept. 10	Sept. 14	2	8	12	....
34	15	...do....	....	....	Sept. 15	....	....	13	....
35	11	...do....	....	....	Sept. 16	....	....	14	2
36	109	Sept. 3	Sept. 6	Sept. 15	Sept. 18	3	12	15	....
37	16	...do....	....	....	Sept. 19	....	....	16	....
38	1	...do....	....	....	Sept. 20	....	....	17	....
39	4	...do....	....	....	Sept. 21	....	....	18	3
40	24	Sept. 4	Sept. 7	Sept. 17	...do....	3	13	17	....
41	2	...do....	....	....	Sept. 22	....	....	18	....
42	48	Sept. 5	Sept. 8	Sept. 18	...do....	3	13	17	....
43	16	...do....	....	....	Sept. 23	....	....	18	....
44	5	...do....	....	....	Sept. 24	....	....	19	....
45	6	Sept. 6	Sept. 10	Sept. 22	...do....	4	16	18	....
46	2	...do....	....	....	Sept. 25	....	....	19	....
47	27	Sept. 7	Sept. 12	Sept. 23	Sept. 26	5	16	19	....
48	3	...do....	....	....	Sept. 27	....	....	20	....
49	32	Sept. 8	Sept. 13	Sept. 26	Sept. 29	5	18	21	....
50	7	...do....	....	....	Sept. 30	....	....	22	5
51	8	Sept. 10	Sept. 17	Sept. 28	Oct. 2	7	18	22	....
52	2	...do....	....	....	Oct. 3	....	....	23	....
53	4	Sept. 12	Sept. 18	Sept. 29	...do....	6	17	21	....
54	1	...do....	....	....	Oct. 4	....	....	22	....
55	8	Sept. 15	Sept. 20	Sept. 30	...do....	5	15	19	....
56	4	Sept. 22	Sept. 26	Oct. 6	Oct. 8	4	14	16	....
57	4	...do....	....	....	Oct. 9	....	....	17	....
58	2	...do....	....	....	Oct. 10	....	....	18	....
59	6	Sept. 25	Oct. 1	Oct. 10	Oct. 15	6	15	20	....
Average						2.884	9.069	11.862	41
Maximum						7	18	23	....
Minimum						1	5	7	....

SECOND BROOD OF LARVÆ.

Time of hatching.—By reference to Table XX it will be noted that second-brood codling-moth eggs were hatching from August 23 to October 15. Hence the larvæ were hatching over a period of nearly two months.

Length of feeding period.—Observations on the feeding period of the second-brood larvæ are given in Table XXI. Although hatching continued until October 15, none of the larvæ which entered the fruit later than September 11 matured. The first of the second-brood larvæ left the fruit September 25, the last November 21. The average feeding period for all larvæ was 49.160 days; maximum, 77 days; minimum, 31 days. The average feeding period for 47 male larvæ was 46.659 days; maximum, 77 days; minimum, 31 days. The average feeding period for 57 female larvæ was 50.245 days; maximum, 72 days; minimum, 33 days. It will again be noted that the feeding period of female larvæ is longer than that of the male.

TABLE XXI.—*Length of feeding period of second-brood larvæ, stock-jar method, Winthrop, Me., 1913.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		31		33		34		36		37		38		39		40		41	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
3	Aug. 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	1
3	Aug. 24	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	1	....	....
9	Aug. 25	1	....	....	....	....	....	....	....	1	....	....	1	....	1	....	....	....	1
7	Aug. 26	....	....	1	1	....	....	....	....	....	....	....	1	....	....	....	1	1	....
8	Aug. 27	....	....	....	....	....	....	2	....	....	....	1	1	1	....	....	1	....	....
10	Aug. 28	....	....	....	....	....	....	1	....	1	....	3	1	1	1	....	....	....	....
3	Aug. 29	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
1	Aug. 30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20	Sept. 1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13	Sept. 2	....	....	....	....	....	....	....	....	....	....	....	....	1	2	1	....	....	....
2	Sept. 3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	Sept. 4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Sept. 5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Sept. 6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Sept. 8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Sept. 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Sept. 11	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
106 ♂ and ♀.		1	0	1	1	1	0	3	0	2	0	4	4	3	4	2	4	1	2
Sex undetermined.		....		....		....		....		....		....		....		....		....	
Total........		1		2		1		3		2		8		7		6		3	

TABLE XXI.—*Length of feeding period of second-brood larvæ, stock-jar method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		42		43		44		45		46		47		48		49		50	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
3	Aug. 23						1												
3	Aug. 24																		
9	Aug. 25			1	1				1							1			
7	Aug. 26										1								
8	Aug. 27																		1
10	Aug. 28			1		1													
3	Aug. 29				1							1							
1	Aug. 30																1		
20	Sept. 1	1				3			2		1			1	2				2
13	Sept. 2			1		1		1			1		1						
2	Sept. 3														1				
11	Sept. 4							1				1							
2	Sept. 5																		
5	Sept. 6																		
5	Sept. 8																		
2	Sept. 9																		1
2	Sept. 11																		
106 ♂ and ♀.		1	0	3	2	5	1	2	3	0	3	2	1	1	3	1	1	0	4
Sex undetermined.																			
Total		1		5		6		5		3		3		4		2		4	

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		51		52		53		54		55		56		58		61		62	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
3	Aug. 23																		
3	Aug. 24																		
9	Aug. 25																		
7	Aug. 26																		
8	Aug. 27															1			
10	Aug. 28																		
3	Aug. 29																		
1	Aug. 30																		
20	Sept. 1							2	2			2	1		1				
13	Sept. 2						3				1								
2	Sept. 3				1														
11	Sept. 4		2			2	1												
2	Sept. 5																		
5	Sept. 6			1															1
5	Sept. 8		1																
2	Sept. 9																		
2	Sept. 11															1			
106 ♂ and ♀.		0	3	1	1	2	4	2	2	0	1	2	1	0	1	2	0	0	1
Sex undetermined.																			
Total		3		2		6		4		1		3		1		2		1	

TABLE XXI.—*Length of feeding period of second-brood larvæ, stock-jar method, Winthrop, Me., 1913*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		64		65		66		69		70		71		72		75		77	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
3	Aug. 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
3	Aug. 24	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
9	Aug. 25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	Aug. 26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....
8	Aug. 27	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	Aug. 28	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
3	Aug. 29	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1	Aug. 30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20	Sept. 1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
13	Sept. 2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	Sept. 3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	Sept. 4	....	1	....	....	....	1	....	....	....	....	....	....	....	....	....	....	(2)	....
2	Sept. 5	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Sept. 6	1	1	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....
5	Sept. 8	....	....	....	....	....	....	....	....	1	3	....	....	....	....	....	....	....	....
2	Sept. 9	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....
2	Sept. 11	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....
106 ♂ and ♀.		1	2	1	1	0	1	0	1	1	3	0	1	0	1	1	0	1	0
Sex undetermined.		....		....		....		....		....		....		....		....		2	
Total........		3		2		1		1		4		1		1		1		3	

Average length of feeding period, 106 male and female larvæ, 49.160 days; 47 male larvæ, 46.659 days; 57 female larvæ, 50.245 days.

Maximum length of feeding period, 106 male and female larvæ, 77 days; 47 male larvæ, 77 days; 57 female larvæ, 72 days.

Minimum length of feeding period, 106 male and female larvæ, 31 days; 47 male larvæ, 31 days; 57 female larvæ, 33 days.

BAND RECORD EXPERIMENT, 1913–14.

As previously stated, the collecting of codling-moth larvæ from banded trees serves as a basis for comparison of the larvæ living under natural conditions with those reared under laboratory conditions. As shown in Table XXII, the first larvæ left the fruit of the banded trees July 21, while the last were collected October 13. The first of the larvæ reared at the insectary left the fruit July 25.

Out of a total of 1,012 larvæ collected from the bands, but 8 larvæ (less than 1 per cent) transformed during 1913. One parasite (*Ascogaster carpocapsæ* Vier.) emerged in 1913.

Owing to the exceptionally severe winter of 1913–14 the mortality of the wintering larvæ was very high. It was computed that 81.52 per cent of the larvæ were killed, due to the low temperatures.

In the spring of 1914, 82 moths and 96 parasites emerged. The parasites were all of the species *Ascogaster carpocapsæ* Vier.

The well known codling-moth enemy *Tenebroides corticalis* Melsh. was frequently found attacking the larvæ beneath the bands.

TABLE XXII.—*Band record experiment, Winthrop, Me., 1913–14.*

No. of record.	Date of collecting.	Number of larvæ.	Number of moths, 1913.	Number of parasites, 1913.	Number of moths, 1914.	Number of parasites, 1914.	Total number dead larvæ.
1	July 21	2	2				0
2	July 24	3	3				0
3	July 27	4	2	1			1
4	July 30	5	1				4
5	Aug. 2	11			1		10
6	Aug. 5	5				1	4
7	Aug. 8	4			2	2	0
8	Aug. 11	15			2	2	11
9	Aug. 14	25			2	4	19
10	Aug. 17	46			3	5	38
11	Aug. 20	92			8	10	74
12	Aug. 23	102			6	13	83
13	Aug. 26	70			1	14	55
14	Aug. 29	78			5	8	65
15	Sept. 1	94			3	8	85
16	Sept. 4	123			5	11	107
17	Sept. 7	77			6	7	64
18	Sept. 10	51			7	5	39
19	Sept. 13	38			10	1	27
20	Sept. 16	26			5	4	17
21	Sept. 19	27			4	1	22
22	Sept. 22	13			2	0	11
23	Sept. 25	30			2		28
24	Sept. 28	13			3		10
25	Oct. 1	22			2		20
26	Oct. 4	10			1		9
27	Oct. 7	11			1		10
28	Oct. 10	9			1		8
29	Oct. 13	6			0		6
Total		1,012	8	1	82	96	825

Parasites, *Ascogaster carpocapsæ* Vier.

SEASONAL-HISTORY STUDIES OF 1914.

The life-history studies of the codling moth which were commenced in 1913 were continued during the season of 1914. Although the notes secured in 1913 were complete in themselves, it was considered desirable to extend the observations over a period of at least two seasons, in order to note any differences in the behavior of the insect due to climatic variations. All of the explanations and descriptions of the methods used in the studies of 1913 are applicable to the investigations of 1914.

SOURCE OF REARING MATERIAL.

The overwintering larvæ consisted of the larvæ which were reared under laboratory conditions and the larvæ collected from the banded trees, as well as miscellaneous larvæ which were secured from wormy apples. The miscellaneous larvæ passed the winter in corrugated paper strips, while the remainder of the larvæ wintered in the "cocoon racks." The larvæ were kept under normal outdoor conditions throughout the winter.

WINTER-KILLED LARVÆ.

Owing to the low temperatures during the winter of 1913–14 a high mortality of the codling-moth larvæ occurred. The number of larvæ from the banded trees killed by the winter temperatures is estimated at 81.52 per cent. The number of winter-killed larvæ which had been reared under laboratory conditions was 86.61 per cent. The United States Weather Bureau, Climatological Report for the New England section, January, 1914, makes special mention of the cold wave on January 13 and 14. This report states that "at many stations of long record all previous minimum temperatures were exceeded on these dates."

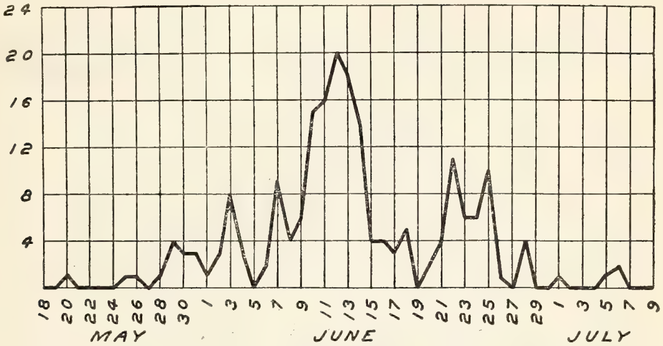


FIG. 5.—Diagram showing pupation of the spring brood of the codling moth in 1914 at Winthrop, Me. (Original.)

SPRING BROOD OF PUPÆ.

Time of pupation.—The first of the spring-brood larvæ pupated May 20, the last July 6. (See fig. 5.) Maximum pupation occurred on June 12, when 20 larvæ pupated. In the preceding year the maximum pupation took place on June 6. (See Table XXIII for the time of pupation.)

TABLE XXIII.—*Time of pupation of overwintering larvæ, Winthrop, Me., 1914.*

Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.	Date of pupation.	Number of pupæ.
May 20	1	June 3	8	June 13	18	June 23	6
May 25	1	June 4	3	June 14	14	June 24	6
May 26	1	June 6	2	June 15	4	June 25	10
May 28	1	June 7	9	June 16	4	June 26	1
May 29	4	June 8	4	June 17	3	June 28	4
May 30	3	June 9	6	June 18	5	July 1	1
May 31	3	June 10	15	June 20	2	July 5	1
June 1	1	June 11	16	June 21	4	July 6	2
June 2	3	June 12	20	June 22	11		
						Total..	197

Length of the pupal stage.—In Table XXIV the length of the pupal stage of 196 spring-brood pupæ is given. The average length of the pupal stage was 22.581 days; maximum, 44 days; minimum, 11 days.

TABLE XXIV.—*Length of pupal stage of spring-brood pupæ, Winthrop, Me., 1914.*

Number of individuals.	Date of pupation.	Length of pupal stage in specified days.																							
		11	12	14	15	16	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	35	43	44
1	May 25	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	May 26	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	May 28	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
4	May 29	...	...	...	...	...	...	...	...	...	...	1	1	2	...	...	...	...	...	...	...	...	...	...	...
3	May 30	...	...	...	...	...	...	...	...	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...
3	May 31	...	...	...	...	...	...	...	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...
1	June 1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
3	June 2	...	...	...	...	...	...	...	...	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...
8	June 3	...	...	...	1	...	...	...	1	3	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...
3	June 4	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	1	...
2	June 6	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	June 7	...	...	...	...	...	...	1	2	3	...	2	...	...	...	...	...	...	1	...	...	...	...	...	...
4	June 8	...	...	...	...	...	...	3	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	June 9	...	...	...	...	...	...	...	...	1	...	...	2	...	...	1	1	1	...	...	...	...	...	...	...
15	June 10	...	...	...	...	...	...	...	...	2	...	8	2	1	...	1	...	...	...	...	...	...	...	...	1
16	June 11	...	...	...	...	...	...	...	2	...	1	4	5	2	1	...	...	...	...	...	1	...	...	...	...
20	June 12	...	1	1	...	...	...	...	...	1	...	3	8	3	1	...	...	...	1	...	...	1	...	...	...
18	June 13	...	...	...	...	...	...	...	1	...	...	2	9	2	...	2	1	...	1	...	...	...	...	...	...
14	June 14	...	...	...	...	1	...	...	...	...	...	5	3	2	...	...	...	...	1	1	...	...	1	...	...
4	June 15	...	...	...	...	...	...	...	...	...	...	1	2	1	...	...	...	...	...	...	...	...	...	...	...
4	June 16	...	...	...	...	...	...	...	...	...	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...
3	June 17	...	...	...	...	...	...	...	...	...	...	2	1	...	...	...	...	...	...	...	...	...	...	...	...
5	June 18	...	...	...	...	...	...	1	...	1	...	2	...	...	...	1	...	...	...	...	...	...	...	...	...
2	June 20	...	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
4	June 21	...	...	...	...	...	...	...	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11	June 22	...	...	1	1	...	...	...	5	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	June 23	...	...	...	...	...	...	1	2	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	June 24	...	...	...	...	...	...	1	2	2	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
10	June 25	...	...	...	...	1	1	2	3	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	June 26	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	June 28	...	...	1	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	July 1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	July 5	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	July 6	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
196 pupæ.....		1	2	3	4	7	1	9	21	24	13	35	40	14	3	6	2	1	4	1	1	1	1	1	1

Average length of the pupal stage, 22.581 days.
Maximum length of the pupal stage, 44 days.
Minimum length of the pupal stage, 11 days.

SPRING BROOD OF MOTHS.

Time of emergence of moths.—In Table XXV is shown the emergence record of 210 spring-brood moths. On June 14 moth emergence commenced and continued until July 19. The maximum emergence occurred July 7, on which date 28 moths appeared. In 1913 the time of moth emergence extended from June 18 to July 20. In 1914 the date of full bloom (Baldwin) was the same as in 1913, namely, May 28.

TABLE XXV.—*Time of emergence of moths of spring brood, Winthrop, Me., 1914. (See fig. 6.)*

Date.	Total.	Date.	Total.	Date.	Total.
June 14	1	July 1	2	July 13	12
June 18	2	July 3	12	July 14	9
June 21	3	July 4	10	July 15	8
June 22	3	July 5	13	July 16	3
June 23	2	July 6	17	July 17	6
June 24	7	July 7	28	July 18	1
June 25	3	July 8	15	July 19	2
June 26	7	July 9	5		
June 27	6	July 10	3		210
June 28	6	July 11	7		
June 30	5	July 12	12		

Time of egg deposition.—The time of egg deposition by moths of the spring brood extended from June 24 to August 5. The average number of days from the time of the emergence of moth to first oviposition was 3.272 days; maximum, 7 days; minimum, 2 days. The average number of days of oviposition was 13.636; maximum, 23 days; minimum, 7 days. The average number of days from the time of the emergence of the moth to the end of oviposition was 16 days; maximum, 24 days; minimum, 9 days. (See Table XXVI.)

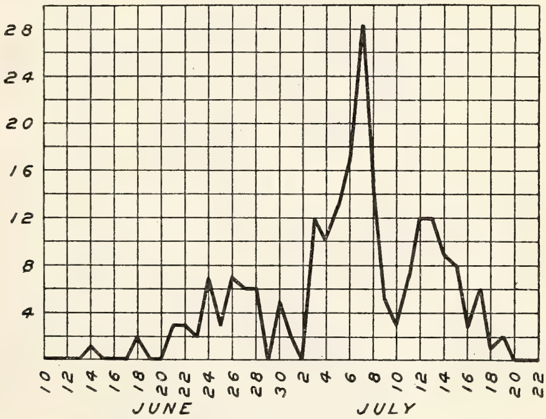


FIG. 6.—Diagram showing emergence of the spring brood of moths of the codling moth in 1914 at Winthrop, Me. (Original.)

TABLE XXVI.—*Oviposition by moths of spring brood in rearing cages. Winthrop, Me., 1914.*

Cage.	Number of moths.	Sex.		Date of—			Number of days—		
		♀	♂	Emergence.	First oviposition.	Last oviposition.	Before oviposition.	Duration of oviposition.	From emergence to end of oviposition.
[1] 1	1 2	2	1	June 14 June 18	June 25	June 26	....	....	....
2	3	1	2	June 21	June 24	July 1	3	8	11
[1] 3	3 2 6 3	4	10	June 22 June 23 June 24 June 25	July 1	July 11	....	....	....
[1] 4	7 6 6	6	13	June 26 June 27 June 28	July 4	July 18	....	....	....
[1] 5	5 2	2	5	June 30 July 1	July 5	July 16	....	....	....
6	12	6	6	July 3	July 8	July 14	5	7	11
7	10	3	7	July 4	July 11	July 20	7	10	16
8	13	7	6	July 5	July 8	...do....	3	13	15
9	17	6	11	July 6	...do....	July 30	2	23	24
10	28	13	15	July 7	July 9	...do....	2	22	23
11	14	7	7	July 8	July 11	July 25	3	15	17
[1] 12	5 3	2	6	July 9 July 10	July 14	July 16	....	....	....
13	7	4	3	July 11	...do....	July 20	3	7	9
14	12	5	7	July 12	July 15	July 25	3	11	13
15	9	4	5	July 14	July 17	Aug. 3	3	18	20
[1] 16	8 3 6 1 2	9	11	July 15 July 16 July 17 July 18 July 19	July 18	Aug. 5	....	....	....
17	12	7	5	July 13	July 15	July 30	2	16	17
Number of male moths				88	Average		3.272	13.636	16
Number of female moths				120	Maximum		7	23	24
Total number of moths				208	Minimum		2	7	9
Total number of eggs				2,907					

[1] Not used in the averages.

Number of eggs per female.—As recorded in Table XXVI, 120 female moths confined in cages with male moths deposited a total of 2,907 eggs. From these data the average number of eggs per female was found to be 24.225.

Length of life of moths.—In Table XXVII will be found the length of the life of 72 male and 66 female moths of the spring brood. The average life of the male moth was 13.708 days; of the female, 13.621 days. The maximum life of the male moth was 32 days; of the female, 28 days. The minimum life of the male moth was 2 days; of the female, 1 day.

TABLE XXVII.—*Length of life of male and female moths of spring brood in captivity. Summary of records of 138 individual moths, Winthrop, Me., 1914.*

Male.		Female.		Male.		Female.	
Length of life.	Number of moths.	Length of life.	Number of moths.	Length of life.	Number of moths.	Length of life.	Number of moths.
Days.		*Days.*		*Days.*		*Days.*	
2	1	1	2	17	6	17	4
3	1	5	1	18	3	18	4
6	3	6	6	19	5	20	2
7	3	7	2	20	3	21	2
8	1	8	3	21	1	22	2
9	9	9	2	22	1	24	1
10	7	10	4	23	1	25	1
11	3	11	2	24	1	27	1
12	5	12	3	27	1	28	2
13	5	13	10	32	1		
14	4	14	7				
15	2	15	4		72		66
16	5	16	1				

Average length of life of male moths, 13.708 days; female moths, 13.621 days.
Maximum length of life of male moths, 32 days; female moths, 28 days.
Minimum length of life of male moths, 2 days; female moths, 1 day.

THE FIRST GENERATION.

FIRST BROOD OF EGGS.

Length of incubation.—Observations of the embryological changes and incubation periods of 2,672 eggs are recorded in Table XXVIII. Of this number, 2,633 (98.54 per cent) hatched. The average number of days from the time of oviposition to the appearance of the red ring was 2.599; maximum, 5 days; minimum, 2 days. The average number of days from the time of oviposition to the appearance of the black spot was 6.139; maximum, 10 days; minimum, 5 days. The average incubation period was 7.797 days; maximum, 13 days; minimum, 6 days.

TABLE XXVIII.—*Length of incubation of first-brood eggs, Winthrop, Me., 1914.*

No. of observation.	Number of eggs.	Date—				Appearance of—		Incubation period.	Number dead.
		Deposited.	Red ring.	Black spot.	Hatched.	Red ring.	Black spot.		
						Days.	*Days.*	*Days.*	
1	4	June 24	June 27	July 4	July 6	3	10	12	1
2	3	June 25	June 28	do	July 7	3	9	12	
3	15	do			July 8			13	1
4	4	June 26	June 30	July 5	do	4	9	12	
5	2	June 27	July 2	July 7	do	5	10	11	
6	43	July 1	July 4	July 8	July 10	3	7	9	
7	7	do			July 11			10	
8	18	July 3	July 5	July 9	July 10	2	6	7	
9	2	do			July 11			8	
10	6	July 4	July 6	July 11	July 12	2	7	8	
11	2	do			July 13			9	
12	92	July 5	July 7	July 12	do	2	7	8	
13	22	do			July 14			9	7
14	29	July 6	July 8	July 13	do	2	7	8	
15	12	do			July 15			9	
16	132	July 8	July 11	July 14	do	3	6	7	
17	84	do			July 16			8	5
18	19	July 9	July 12	July 15	do	3	6	7	
19	9	do			July 17			8	
20	115	July 10	July 13	July 16	do	3	6	7	
21	27	do			July 18			8	4
22	102	July 11	July 13	July 16	July 17	2	5	6	
23	20	do			July 18			7	
24	110	July 12	July 14	July 17	do	2	5	6	
25	160	do			July 19			7	
26	21	do			July 20			8	
27	101	July 13	July 15	July 18	do	2	5	7	
28	17	do			July 21			8	2
29	106	July 14	July 16	July 20	do	2	6	7	
30	12	do			July 22			8	
31	70	July 15	July 17	July 21	do	2	6	7	
32	60	do			July 23			8	
33	142	July 16	July 18	July 22	do	2	6	7	
34	27	do			July 24			8	7
35	187	July 17	July 20	July 23	do	3	6	7	
36	52	do			July 25			8	8
37	42	July 18	July 21	July 24	July 26	3	6	8	
38	90	do			July 27			9	3
39	17	July 19	July 22	July 25	do	3	6	8	
40	12	do			July 28			9	
41	63	July 20	July 23	July 26	do	3	6	8	
42	28	do			July 29			9	
43	33	July 21	July 24	July 28	July 30	3	7	9	
44	9	do			July 31			10	
45	38	July 22	July 25	July 29	do	3	7	9	
46	17	do			Aug. 1			10	
47	16	July 23	July 26	July 30	do	3	7	9	
48	6	do			Aug. 2			10	
49	57	July 24	July 27	July 31	do	3	7	8	
50	9	do			Aug. 3			9	
51	106	July 25	July 28	Aug. 1	do	3	7	9	
52	70	do			Aug. 4			10	
53	13	July 26	July 29	Aug. 3	do	3	8	9	
54	16	do			Aug. 5			10	
55	1	July 27	July 30	Aug. 3	do	3	7	9	
56	15	do			Aug. 6			10	
57	7	July 28	July 31	Aug. 4	do	3	7	9	
58	16	do			Aug. 7			10	
59	12	July 30	Aug. 3	Aug. 6	do	4	7	8	
60	89	do			Aug. 8			9	1
61	23	July 31	Aug. 4	Aug. 7	Aug. 9	4	7	9	
62	9	Aug. 1	do	Aug. 8	do	3	7	8	
63	18	Aug. 2	Aug. 5	Aug. 9	Aug. 10	3	7	8	
64	5	Aug. 3	Aug. 6	do	Aug. 11	3	6	8	
65	1	Aug. 5	Aug. 8	Aug. 11	Aug. 12	3	6	7	
Average						2.599	6.139	7.797	39
Maximum						5	10	13	
Minimum						2	5	6	

FIRST BROOD OF LARVÆ.

Time of hatching.—The first-brood larvæ commenced to hatch July 6. The last of the larvæ hatched August 12. Hatching, therefore, extended for a period of slightly over one month. The maximum number of larvæ hatched July 24. (See Table XXVIII.)

Length of the feeding period of the transforming larvæ.—During the season of 1914 two methods, namely, the stock-jar and bagged-fruit methods, were used for determining the feeding period of the first-brood larvæ. These methods are described on page 10.

As in 1913, only a very small number of the first-brood larvæ transformed to first-brood moths. Out of a total of 845 larvæ reared at the laboratory 12 (1.4 per cent) transformed.

In Table XXIX is given the length of the feeding period of the transforming larvæ of the first brood (stock-jar method). The average length of the feeding period for male and female larvæ was 19.666 days; maximum, 21 days; minimum, 17 days. Average for male larvæ, 21 days; maximum, 21 days; minimum, 21 days. Average for female larvæ, 19.285 days; maximum, 21 days; minimum, 17 days.

TABLE XXIX.—*Length of feeding period of transforming larvæ of the first brood, stock-jar method, Winthrop, Me., 1914.*

No. of observation.	Date of—		Sex.	Days of feeding.
	Hatching.	Leaving fruit.		
1	July 6	July 24	♀	18
2	...do....	July 27	♂	21
3	July 8	...do....	♀	19
4	...do....	July 28	♀	20
5	...do....	July 29	♂	21
6	July 9	...do....	♀	20
7	July 10	July 27	♀	17
8	...do....	July 31	♀	21
9	July 13	Aug. 2	♀	20

Average length of feeding period, male and female larvæ, 19.666 days; male, 21 days; female, 19.285 days.
Maximum length of feeding period, male and female larvæ, 21 days; male, 21 days; female, 21 days.
Minimum length of feeding period, male and female larvæ, 17 days; male, 21 days; female, 17 days.

The length of the feeding period of the transforming larvæ of the first brood (bagged-fruit method) is given in Table XXX. The average length of the feeding period was 25.333 days; maximum, 26 days; minimum, 24 days. The average for the male larvæ was 25 days; maximum, 26 days; minimum, 24 days. No record for female larvæ was secured.

The average feeding period for all transforming larvæ was 21.082 days, as given in Table XXXVIII.

TABLE XXX.—*Length of the feeding period of transforming larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1914.*

No. of observation.	Date of—		Sex.	Days of feeding.
	Hatching.	Leaving fruit.		
1	July 15	Aug. 10	....	26
2	July 17	...do....	♂	24
3	July 19	Aug. 14	♂	26

Average length of feeding period, male and female larvæ, 25.333 days; male, 25 days.
Maximum length of feeding period, male and female larvæ, 26 days; male, 26 days.
Minimum length of feeding period, male and female larvæ, 24 days; male, 24 days.

Length of the feeding period of wintering first-brood larvæ (stock-jar method).—Observations were taken on the length of feeding of 341 larvæ, as is given in Table XXXI. The average length of the feeding period for all larvæ was 25.717 days; maximum, 46 days; minimum, 19 days. The average length of feeding for the male larvæ was 23.935 days; for the female larvæ, 27.022 days. The maximum length of the feeding period for the male larvæ was 46 days; for the female larvæ, 46 days. The minimum length of the feeding period for the male larvæ was 19 days; for the female larvæ, 19 days.

TABLE XXXI.—*Length of feeding period of the wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1914.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		19		20		21		22		23		24		25		26	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
2	July 7				1							1					
4	July 8					1				1			1				1
2	July 9														1		
5	July 11		1				1			1		1					
4	July 12	1	1		1		1										
3	July 13			1			1					(1)					
9	July 14			1			1							1	1	(1)	
14	July 15									1		2	3	1			
9	July 16															1	1
18	July 17							1				2	1	2	2	1	1
11	July 18									1	1	1	2				
19	July 19									1	1		2	1	(1)		
3	July 20									1		1					
20	July 21									1		(1)2	1		4		
6	July 22							1		1					1	1	1
6	July 23										2	1	3				
11	July 24		1					1		1		1	2				2
33	July 25							1	1	1	4	2	4	1	(1)	1(1)	3
4	July 26													1	1		
9	July 28							(1)			1		2		2		
10	July 29											1	3		2		2
19	July 31					1		3	1	1	4	1	3	1			
24	Aug. 1			1	(1)	3		2	1	2	4	4	3		1		1
16	Aug. 2					1					3	2	1	2	3	1	1
40	Aug. 3			1	1	4	1	3(1)	1	3	1	5	2	(2)	1		1
13	Aug. 4						1	(1)	1	1	(1)		1	1			2
10	Aug. 5					3		2		1			1	2			
5	Aug. 6								1					1	2	1	
10	Aug. 8											1	1	3	1	2	
2	Aug. 9																
341 ♂ and ♀		1	3	4	3	13	6	14	6	18	21	28	36	17	22	8	16
Sex undetermined		0		1		0		3		1		2		4		2	
Total		4		8		19		23		40		66		43		26	

TABLE XXXI.—*Length of feeding period of the wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1914*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		27		28		29		30		31		32		33		34	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
2	July 7	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
4	July 8	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
2	July 9	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....
5	July 11	....	....	....	....	(1)	....	....	....	....	....	....	....	....	....	....	....
4	July 12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
3	July 13	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
9	July 14	....	1	....	1	....	....	....	....	1	1	....	....	....	....	....	....
14	July 15	2	....	1	....	1	....	....	....	....	....	....	....	....	....	....	....
9	July 16	....	....	....	....	....	....	....	....	(1)2	2	....	....	....	....	....	....
18	July 17	1	....	1	1	2	....	1	....	2	....	....	....	....	....	....	....
11	July 18	....	2	2	1	....	1	....	....	....	....	....	....	....	....	....	....
19	July 19	(1)	3	....	1	....	1	....	2	....	....	1	1	....	....	....	....
3	July 20	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
20	July 21	....	2	2	2	(1)	....	1	....	....	....	....	1	....	....	1	....
6	July 22	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....
6	July 23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
11	July 24	....	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....
33	July 25	(2)	....	(1)1	3	1	1	....	1	....	....	....	1	1	....	....	....
4	July 26	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....
9	July 28	....	2	....	....	....	....	....	1	....	....	....	....	....	....	....	....
10	July 29	....	....	....	....	....	....	....	....	....	....	....	....	(1)	....	....	1
19	July 31	1	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1
24	Aug. 1	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
16	Aug. 2	....	....	....	....	....	....	(1)	1	....	....	....	....	....	....	....	....
40	Aug. 3	1	1	1	2	1(1)	4	....	....	....	....	....	1	....	1	....	....
13	Aug. 4	....	....	1(1)	2	....	....	....	....	....	....	....	....	....	....	....	....
10	Aug. 5	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....
5	Aug. 6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	Aug. 8	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....
2	Aug. 9	1	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....
341 ♂ and ♀		7	11	12	16	5	10	2	6	5	4	1	4	1	2	1	2
Sex undetermined		3		2		3		1		1		0		1		0	
Total		21		30		18		9		10		5		4		3	

TABLE XXXI.—*Length of feeding period of the wintering larvæ of the first brood, stock-jar method, Winthrop, Me., 1914*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.													
		35		36		37		38		40		41		46	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
2	July 7														
4	July 8														
2	July 9														
5	July 11														
4	July 12														
3	July 13														
9	July 14														
14	July 15				1	1			1						
9	July 16	(1)									1				
18	July 17														
11	July 18														
19	July 19											1		1	1
3	July 20														
20	July 21						1								
6	July 22														
6	July 23														
11	July 24		1												
33	July 25				1										
4	July 26														
9	July 28														
10	July 29														
19	July 31		1												
24	Aug. 1														
16	Aug. 2														
40	Aug. 3														
13	Aug. 4														
10	Aug. 5														
5	Aug. 6														
10	Aug. 8														
2	Aug. 9														
341 ♂ and ♀		0	2	0	2	1	1	0	1	0	1	1	0	1	1
Sex undetermined		1		0		0		0		0		0		0	
Total		3		2		2		1		1		1		2	

Average length of feeding period, 341 male and female larvæ, 25.717 days; 140 male larvæ, 23.935 days; 176 female larvæ, 27.022 days.

Maximum length of feeding period, 341 male and female larvæ, 46 days; 140 male larvæ, 46 days; 176 female larvæ, 46 days.

Minimum length of feeding period, 341 male and female larvæ, 19 days; 140 male larvæ, 19 days; 176 female larvæ, 19 days.

Length of the feeding period of wintering first-brood larvæ (bagged-fruit method).—Table XXXII records the feeding period of 492 wintering first-brood larvæ. The average feeding period of these larvæ was 31.865 days; maximum, 55 days; minimum, 24 days. The average feeding period for 226 male larvæ was 30.960 days; maximum, 55 days; minimum, 24 days. The average feeding period for 213 female larvæ was 32.436 days; maximum, 55 days; minimum, 25 days.

Table XXXII.—*Length of feeding period of the wintering larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1914.*

[Figures in parentheses ( ) denote sex undetermined.]

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		24		25		26		27		28		29		30		31	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
20	July 10	....	....	(1)	1	....	....	2	1(1)	3	1	1(1)	2	....	....	....	....
8	July 11	....	....	(1)	....	2	....	....	....	....	....	....	....	1	....	2	1
22	July 13	....	....	1	1	1	....	4	4	(1)3	3	....	1	1	....	....	....
29	July 14	....	....	3	1(2)	1	2	4	2	4	2(3)	1	....	1	1	....	1
22	July 15	....	....	....	....	1	....	....	....	1	....	1	(1)	2	3	....	....
20	July 16	....	....	....	....	....	....	....	....	....	1	3	....	(1)2	1	1	2
42	July 17	1	....	....	....	(1)	1	3	....	3	3	....	1	(2)7	4	1	4
42	July 18	....	....	1	....	....	....	2	1	2	3	3	2	4	4	(1)1	2
21	July 19	....	....	....	....	1	....	....	....	1	....	5	1	1	....	2	....
18	July 20	....	....	2	....	....	1	1	1	....	....	2	2	....	....	1	1
21	July 21	1	....	....	....	2	....	....	....	....	....	2	1	1	3	....	2
16	July 22	....	....	(1)	1	....	1	2	....	....	....	2	....	....	1	....	1
13	July 23	....	....	....	....	2	....	1	1	1	1	....	....	1	2	....	1
20	July 24	....	....	....	....	....	1	2	....	....	....	2	1	2	....	1	....
42	July 25	....	....	....	....	....	....	(2)	....	1	2	4	(1)4	2	1	1	....
13	July 26	....	....	....	....	1	....	....	1	....	....	1	....	1	....	....	2
8	July 27	....	....	....	....	....	....	....	....	....	....	....	....	3	....	....	....
12	July 28	....	....	....	....	....	....	....	....	1	....	....	....	1	....	....	....
8	July 30	....	....	....	....	....	....	....	....	1	....	....	....	1	....	....	....
14	July 31	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....
3	Aug. 2	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....
28	Aug. 3	....	....	....	....	....	....	....	....	....	....	2	3	2	....	....	1
14	Aug. 4	....	....	....	....	....	....	....	....	1	....	1	....	....	....	1	....
1	Aug. 5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
4	Aug. 6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
5	Aug. 7	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1	....
15	Aug. 8	....	....	....	....	....	....	....	....	1	....	....	....	....	....	1	....
6	Aug. 9	....	....	....	....	....	....	....	....	1	....	....	2	....	....	....	....
3	Aug. 10	....	....	....	....	1	....	....	....	....	....	....	....	....	....	(1)	....
2	Aug. 11	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....
492 ♂ and ♀		2	0	7	4	12	6	21	11	26	17	30	20	35	20	13	18
Sex undetermined		0		5		1		3		4		3		3		2	
Total		2		16		19		35		47		53		58		33	

TABLE XXXII.—*Length of feeding period of the wintering larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1914*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.															
		32		33		34		35		36		37		38		39	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
20	July 10	....	....	....	....	....	....	....	1	2	....	....	....	....	....	....	....
8	July 11	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....
22	July 13	(2)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
29	July 14	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....
22	July 15	3	2	1	(1)2	....	....	....	4	....	....	....	....	....	....	....	....
20	July 16	....	1	2	(1)2	....	2	....	1	....	....	....	....	....	....	....	....
42	July 17	....	2	1	1	2	1	....	1	....	....	....	2	....	....	....	....
42	July 18	(1)2	1	3	(1)4	....	....	1	....	....	....	....	....	....	....	....	....
21	July 19	2	2	1	1	....	2	....	....	....	1	....	....	....	....	(1)	....
18	July 20	1	(3)	....	....	(2)	....	1	....	....	....	....	....	....	....	....	....
21	July 21	3	2	3	....	....	....	....	....	....	....	....	1	....	....	....	....
16	July 22	....	2	....	....	1	1	1	1	....	1	....	....	....	....	....	....
13	July 23	....	1	1	....	....	....	....	....	....	....	....	1	....	....	....	....
20	July 24	1	1	....	....	....	1	1	2	....	....	1	....	....	1	(1)	1
42	July 25	2	3	1	2	....	....	....	1	3	1	2	1	1	2	(1)	2
13	July 26	1	1	....	....	....	....	....	....	....	2	....	....	....	....	....	2
8	July 27	....	2	....	(1)	2	....	....	....	....	....	....	....	....	....	....	....
12	July 28	1(1)	1	....	....	....	....	1(1)	1	....	....	1	2	(1)	....	....	....
8	July 30	....	1	....	....	....	2	....	1	....	....	....	....	1	....	1	....
14	July 31	1	1	....	3	(1)	1	....	2	....	1	1	....	....	....	(1)	....
3	Aug. 2	....	....	....	1	....	1	....	....	....	....	....	....	....	....	....	....
28	Aug. 3	....	....	....	1	1	....	1	2	1	1	2	1	....	....	....	....
14	Aug. 4	....	....	....	2	....	2	2	....	....	....	....	....	....	....	1	1
1	Aug. 5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
4	Aug. 6	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1
5	Aug. 7	....	....	1	....	1	....	....	....	1	....	....	....	....	....	....	....
15	Aug. 8	1	....	....	....	....	....	1	....	....	....	....	1	1(1)	3	(1)	....
6	Aug. 9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(1)	1
3	Aug. 10	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
2	Aug. 11	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
492 ♂ and ♀		19	24	14	20	7	14	9	18	7	7	8	8	3	6	2	8
Sex undetermined		7		4		3		1		0		0		2		6	
Total		50		38		24		28		14		16		11		16	

TABLE XXXII.—*Length of feeding period of the wintering larvæ of the first brood, bagged-fruit method, Winthrop, Me., 1914*—Continued.

Number of individuals.	Date of entering fruit.	Length of feeding period in specified days.																	
		40		41		42		43		44		45		46		48		55	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
20	July 10			1														1	1
8	July 11																		
22	July 13																		
29	July 14																		
22	July 15																		
20	July 16																		
42	July 17												1						
42	July 18			1						(1)		1							
21	July 19																		
18	July 20																		
21	July 21																		
16	July 22																		
13	July 23																		
20	July 24																1		
42	July 25		1			1													
13	July 26							1											
8	July 27																		
12	July 28																		
8	July 30																		
14	July 31			1															
3	Aug. 2																		
28	Aug. 3	(1)	4	1		1	1	(1)							1				
14	Aug. 4				1	(2)													
1	Aug. 5				(1)														
4	Aug. 6															1			
5	Aug. 7																		
15	Aug. 8					1				(2)				(1)					
6	Aug. 9		1																
3	Aug. 10																		
2	Aug. 11																		
492 ♂ and ♀		0	6	4	1	3	1	1	0	0	0	1	1	0	1	1	1	1	1
Sex undetermined		1		1		2		1		3		0		1		0		0	
Total		7		6		6		2		3		2		2		2		2	

Average length of feeding period, 492 male and female larvæ, 31.865 days; 226 male larvæ, 30.960 days; 213 female larvæ, 32.436 days.

Maximum length of feeding period, 492 male and female larvæ, 55 days; 226 male larvæ, 55 days; 213 female larvæ, 55 days.

Minimum length of feeding period, 492 male and female larvæ, 24 days; 226 male larvæ, 24 days; 213 female larvæ, 25 days.

As was noted in 1913, the average feeding period of the transforming larvæ was shorter than that of the overwintering larvæ. Likewise the feeding period of the larvæ reared by the bagged-fruit method was longer than the feeding period of larvæ reared by any other method. The fact that female larvæ feed on an average for a longer time than the male larvæ was again proven in 1914.

Larval life in the cocoon.—The average number of days spent by the larvæ in constructing their cocoons was 6.166; maximum, 9 days; minimum, 3 days. (See Table XXXIII.)

TABLE XXXIII.—*Length of the pupal stage of the first brood, Winthrop, Me., 1914.*

No. of observation.	Date of—			Making of cocoon.	Pupal period.	No. of observation.	Date of—			Making of cocoon.	Pupal period.
	Leaving fruit.	Pupation.	Emergence.				Leaving fruit.	Pupation.	Emergence.		
				Days.	*Days.*					*Days.*	*Days.*
1	July 24	July 27	Aug. 11	3	15	7	July 29	Aug. 5	Aug. 18	7	13
2	July 27	Aug. 3	Aug. 17	7	14	8	July 31	Aug. 6	Aug. 20	6	14
3	...do.....	...do	...do	7	14	9	Aug. 2	Aug. 9	Aug. 27	7	18
4	...do.....	Aug. 4	Aug. 18	8	14	10	Aug. 10	Aug. 15	Sept. 2	5	18
5	July 28	Aug. 6	Aug. 20	9	14	11	...do.....	Aug. 18	Sept. 5	8	18
6	July 29	Aug. 2	Aug. 16	4	14	12	Aug. 14	Aug. 17	Sept. 3	3	17
Average										6.166	15.250
Maximum										9	18
Minimum										3	13

FIRST BROOD OF PUPÆ OR SUMMER PUPÆ.

Time of pupation.—Pupation of the first brood commenced July 27 and extended until August 18, as shown in Table XXXIII. (See fig. 7.)

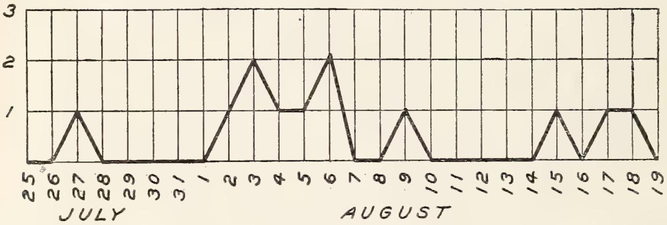


FIG. 7.—Diagram showing pupation of the first brood of the codling moth in 1914 at Winthrop, Me. (Original.)

Length of the pupal stage.—Table XXXIII records the length of the pupal period of 12 individuals. As will be noted, the average length of the pupal period was 15.250 days; maximum, 18 days; minimum, 13 days.

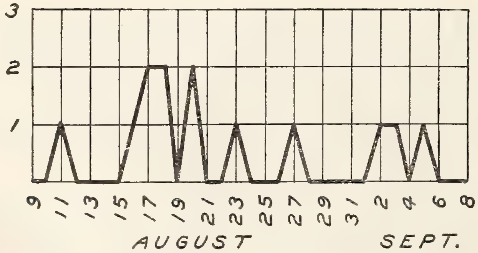


FIG. 8.—Diagram showing emergence of the first brood of moths of the codling moth in 1914 at Winthrop, Me. (Original.)

FIRST OR SUMMER BROOD OF MOTHS.

Time of emergence.—The moths of the summer brood commenced to issue August 11. The last moth emerged September 5. The record of the moth emergence is given in Table XXXIV. (See fig. 8.)

TABLE XXXIV.—*Time of emergence of moths of the first or summer brood, Winthrop, Me., 1914.*

Date of emergence.	Total emergence.	Date of emergence.	Total emergence.
Aug. 11	1	Aug. 27	1
Aug. 16	1	Sept. 2	1
Aug. 17	2	Sept. 3	1
Aug. 18	2	Sept. 5	1
Aug. 20	2		
Aug. 23	1		13

Time of oviposition.—As shown in Table XXXV, the first eggs were deposited by the summer-brood moths on August 20. The last oviposition occurred September 20.

TABLE XXXV.—*First or summer brood of moths, Winthrop, Me., 1914.*

CAGE I.					CAGE II.				
Date.	Number of moths emerged.	Eggs deposited.	Death of moths.		Date.	Number of moths emerged.	Eggs deposited.	Death of moths.	
			Male.	Female.				Male.	Female.
Aug. 11	1	....	....	....	Sept. 2	1	....	....	....
Aug. 16	1	....	....	....	Sept. 3	1	....	....	....
Aug. 17	2	....	....	....	Sept. 5	1	....	....	....
Aug. 18	2	....	....	....	Sept. 7	....	Eggs..	....	....
Aug. 20	2	Eggs..	....	....	Sept. 10	....	...do...	....	....
Aug. 22	....	...do...	....	....	Sept. 11	....	...do...	....	....
Aug. 23	1	....	....	....	Sept. 12	....	...do...	....	....
Aug. 24	....	Eggs..	....	....	Sept. 13	....	...do...	....	....
Aug. 25	....	...do...	....	....	Sept. 14	....	...do...	....	....
Aug. 26	....	....	....	1	Sept. 15	....	...do...	....	....
Aug. 28	....	Eggs..	....	....	Sept. 18	....	...do...	....	....
Aug. 30	....	....	2	1	Sept. 20	....	...do...	....	1
Aug. 31	....	....	1	2	Sept. 21	....	....	....	1
Sept. 2	....	....	....	2	Sept. 22	....	....	1	....
	9	....	3	6		3	....	1	2

Number of eggs per first-brood female moth.—The total number of eggs deposited by 8 female moths kept in confinement with male moths was 181. Hence the average number of eggs per female was 22.625.

LENGTH OF LIFE CYCLE OF THE FIRST GENERATION.

The life cycle of the first generation of the codling moth is given in two tables, Tables XXXVI and XXXVII. The life cycle considered in these tables extends from the time of egg deposition to the emergence of the moth and hence is not the complete life cycle. For the complete life cycle there should be added to the figures recorded about four days, which is the time from the emergence of the moth until the first oviposition. As will be noted in the tables, the average life cycle (stock-jar method) was 50.222 days; bagged-fruit method averaged for 3 individuals 55 days.

TABLE XXXVI.—*Life cycle of first generation of codling moth as observed by rearing at Winthrop, Me., 1914, stock-jar feeding method.*

No. of observation.	Date of—					Days for—				
	Egg deposition.	Hatching.	Larvæ leaving the fruit.	Pupation.	Emergence of moths.	Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
1♀	June 24	July 6	July 24	July 27	Aug. 11	12	18	3	15	48
2♂	...do.....	...do.....	July 27	Aug. 3	Aug. 17	12	21	7	14	54
3♀	June 27	July 8	...do.....	...do.....	...do.....	11	19	7	14	51
4♀	...do.....	...do.....	July 28	Aug. 6	Aug. 20	11	20	9	14	54
5♂	...do.....	...do.....	July 29	Aug. 5	Aug. 18	11	21	7	13	52
6♀	July 1	July 9	...do.....	Aug. 2	Aug. 16	8	20	4	14	46
7♀	July 3	July 10	July 27	Aug. 4	Aug. 18	7	17	8	14	46
8♀	...do.....	...do.....	July 31	Aug. 6	Aug. 20	7	21	6	14	48
9♀	July 5	July 13	Aug. 2	Aug. 9	Aug. 27	8	20	7	18	53
Average						9. 666	19. 666	6. 444	14. 444	50. 222
Maximum						12	21	9	18	54
Minimum						7	17	3	13	46

[1] Add 4 days for complete life cycle.

TABLE XXXVII.—*Life cycle of first generation of codling moth as observed by rearing at Winthrop, Me., 1914, bagged-fruit feeding method.*

No. of observation.	Date of—					Days for—				
	Egg deposition.	Hatching.	Larva leaving the fruit.	Pupation.	Emergence of moths.	Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
1	July 8	July 15	Aug. 10	Aug. 15	Sept. 2	7	26	5	18	56
2♂	July 11	July 17	...do....	Aug. 18	Sept. 5	6	24	8	18	56
3♂	July 12	July 19	Aug. 14	Aug. 17	Sept. 3	7	26	3	17	53
Average						6. 666	25. 333	5. 333	17. 666	55
Maximum						7	26	8	18	56
Minimum						6	24	3	17	53

[1] Add 4 days for complete life cycle.

A summary of Tables XXXVI and XXXVII is given in Table XXXVIII, which shows that the average life cycle of the first generation of all individuals was 51.416 days. The complete life cycle would be about 55–56 days.

TABLE XXXVIII.—*Summary of life cycle of first generation of codling moth, Winthrop, Me., 1914.*

	Number of observations.	Larval feeding method.	Days for—				
			Hatching.	Feeding.	Making of cocoon.	Pupal period.	Life cycle.[1]
Average life cycle	9	A	9. 666	19. 666	6. 444	14. 444	50. 222
Do	3	B	6. 666	25. 333	5. 333	17. 666	55. 000
Average of all life cycles.	12	A+B	8. 916	21. 082	6. 166	15. 249	51. 416

[1] Add 4 days for complete life cycle.

A, stock-jar method; B, bagged-fruit method.

THE SECOND GENERATION.

SECOND BROOD OF EGGS.

Length of incubation.—On August 20 the first egg of the second brood was deposited. Oviposition continued until September 18, reaching the maximum on August 31. Out of 138 eggs deposited 96 (69.56 per cent) hatched. The average incubation period was 10.208 days; maximum, 15 days; minimum, 8 days. The average time from the time of egg deposition to the appearance of the red ring was 4.754 days; maximum, 9 days; minimum, 3 days. The average time for the appearance of the black spot was 8.368 days; maximum, 14 days; minimum, 6 days. (See Table XXXIX.).

TABLE XXXIX.—*Length of incubation period of second-brood eggs, Winthrop, Me., 1914.*

No. of observation.	Number of eggs.	Date—				Appearance of—		Incubation period.	Number dead.
		Deposited.	Red ring.	Black spot.	Hatched.	Red ring.	Black spot.		
						Days.	*Days.*	*Days.*	
1	1	Aug. 20							1
2	8	Aug. 22							8
3	1	Aug. 24	Aug. 29	Sept. 2	Sept. 4	5	9	9	
4	13	Aug. 25	Aug. 30	do.	do.	5	8	10	
5	10	do.			Sept. 5			11	3
6	9	Aug. 26	Aug. 31	Sept. 3	do.	5	8	10	
7	7	do.			Sept. 6			11	3
8	1	Aug. 27	Sept. 1	Sept. 4	Sept. 8	5	8	12	
9	3	Aug. 28	Sept. 4	Sept. 6	Sept. 9	7	9	12	1
10	6	Aug. 31	Sept. 5	do.	Sept. 8	5	6	8	
11	28	do.			Sept. 9			9	4
12	10	Sept. 7	Sept. 12	Sept. 19	Sept. 21	5	12	14	1
13	3	Sept. 10	Sept. 15	Sept. 21		5	11		3
14	2	Sept. 11	do.	do.		4	10		2
15	1	Sept. 12	Sept. 21	Sept. 22	Sept. 23	9	10	11	
16	15	do.			Sept. 24			12	14
17	7	Sept. 13	Sept. 17	Sept. 21	Sept. 23	4	8	10	
18	3	do.			Sept. 24			11	
19	7	Sept. 14	Sept. 17	Sept. 20	Sept. 23	3	6	9	
20	3	Sept. 18	Sept. 22	Oct. 2	Oct. 3	4	14	15	2
Average						4.754	8.368	10.208	42
Maximum						9	14	15	
Minimum						3	6	8	

SECOND BROOD OF LARVÆ.

Time of hatching.—As will be noted in Table XXXIX, the first of the second-brood larvæ hatched September 4. The last of the second-brood larvæ hatched October 3. Hence the period of hatching was about one month.

Length of feeding period.—Observations on the length of the feeding period was limited to 4 individuals. Many of the larvæ which entered the fruit failed to mature. The average feeding period was 42.750 days; maximum, 47 days; minimum, 38 days. The above records are given in Table XL.

TABLE XL.—*Length of feeding period of second-brood larvæ, stock-jar method, Winthrop, Me., 1914.*

Number of larvæ.	Date of hatching.	Date of leaving fruit.	Sex.	Days of feeding.
1	Sept. 8	Oct. 16	♀	38
1	...do.....	Oct. 21	♂	43
1	...do.....	...do.....	♂	43
1	...do.....	Oct. 25	....	47
Average				42.75

BAND-RECORD EXPERIMENT, 1914.

During the season of 1914 a total of 499 larvæ was collected from banded trees. The first larvæ left the fruit August 3, the last October 11. None of these larvæ transformed. (See Table XLI.)

TABLE XLI.—*Band-record experiment, Winthrop, Me., 1914.*

Number of record.	Date of collecting.	Number of larvæ.	Number of moths, 1914.	Number of parasites, 1914.
1	Aug. 3	1	0	0
2	Aug. 6	3	0	0
3	Aug. 9	0	0	0
4	Aug. 12	7	0	0
5	Aug. 15	1	0	0
6	Aug. 18	2	0	0
7	Aug. 21	15	0	0
8	Aug. 24	8	0	0
9	Aug. 27	17	0	0
10	Aug. 30	23	0	0
11	Sept. 2	30	0	0
12	Sept. 5	82	0	0
13	Sept. 8	80	0	0
14	Sept. 11	20	0	0
15	Sept. 14	31	0	0
16	Sept. 17	43	0	0
17	Sept. 20	42	0	0
18	Sept. 23	54	0	0
19	Sept. 26	16	0	0
20	Sept. 29	0	0	0
21	Oct. 2	6	0	0
22	Oct. 5	11	0	0
23	Oct. 8	2	0	0
24	Oct. 11	5	0	0
		499	0	0

COMPARISON OF THE LIFE HISTORY OF THE CODLING MOTH IN 1913 AND 1914.

A comparison of the life history of the codling moth is shown diagrammatically in figure 9. This chart shows the beginning and ending of the different stages of the insect, and, in a general way, the maximum of activity for each phase of the life history. It will be noted that the life histories of the species during 1913 and 1914 corresponded quite closely. Variations were due chiefly to climatic differences which were of comparatively short duration.

In 1913 pupation began somewhat earlier than in 1914. An unusually warm period during the latter part of April and again during the first few days of May, 1913, doubtless exerted some influence on the larvæ. The very early pupæ in 1913, however, were evidently somewhat abnormal and failed to transform to moths. Pupation during both seasons ceased at approximately the same time. The average pupation period of the spring-brood pupæ in 1913 was 19.030 days; in 1914, 22.581 days.

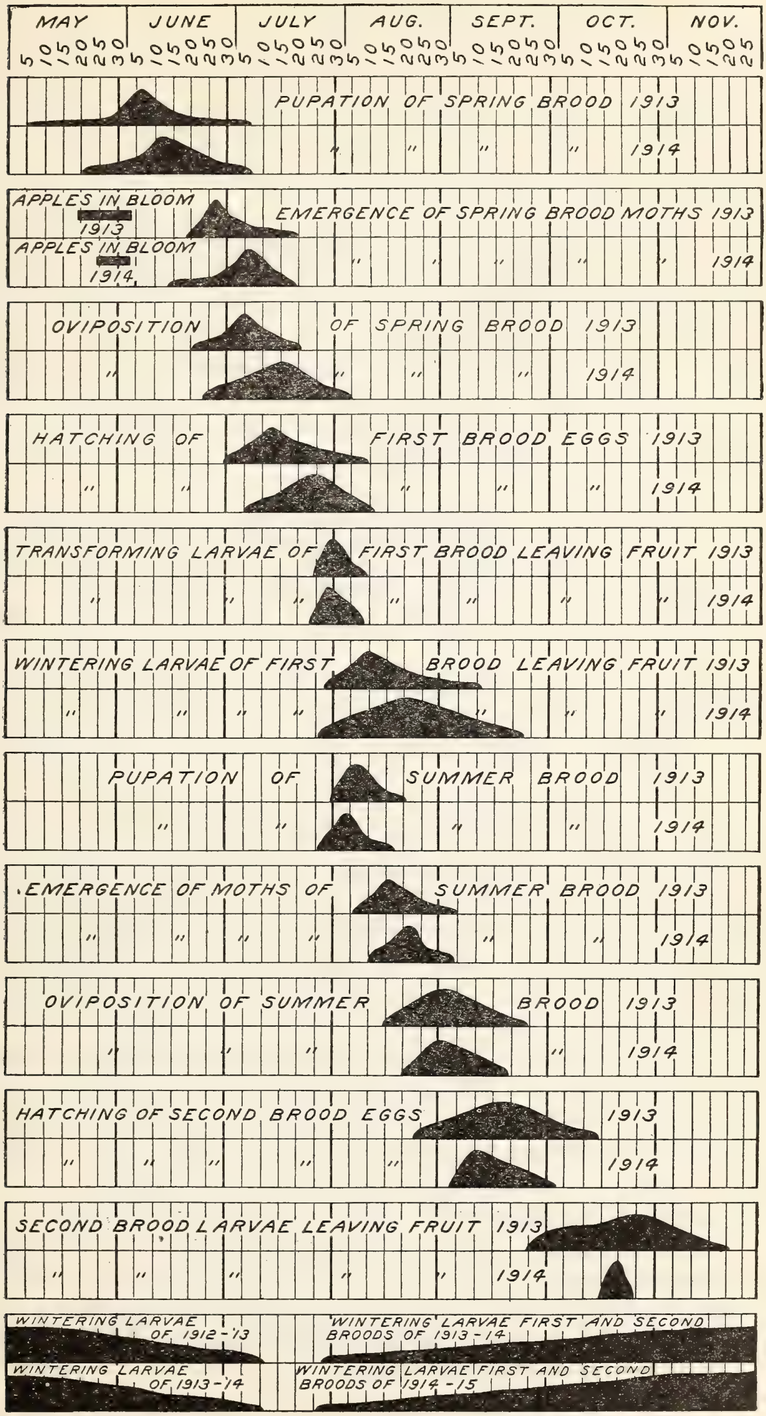


FIG. 9.—Diagram of the seasonal history of the codling moth during the seasons of 1913 and 1914 at Winthrop, Me. (Original.)

In 1913 apples were in bloom from about May 18 to June 4, when the last of the petals had fallen. The temperatures during the blooming period were relatively low, accompanied by considerable precipitation. In 1914 the blooming period was favored with somewhat better weather conditions and, as a result of these climatic conditions, the moths of the spring brood began to issue a few days earlier than in 1913.

The average length of the life of the male spring-brood moth in 1913 was 10.685 days; of the female moth, 12.253 days. In 1914 the average life of the male moth was 13.708 days; female moth, 13.621 days.

Oviposition by moths of the spring brood began at very nearly the same time each year. In 1914, however, the period of oviposition extended about two weeks longer than in the preceding year. The average duration of the oviposition period in 1913 was 14.086 days; in 1914, 13.636 days.

Hatching of the first-brood eggs in 1913 began a few days prior to the date of the earliest hatching in 1914. Likewise hatching ceased in 1913 about three days earlier than in 1914. The average incubation period of the first-brood eggs in 1913 was 8.874 days; in 1914, 7.797 days.

The time of leaving the fruit by transforming larvæ of the first brood was approximately the same during each season. The average feeding period of the tranforming larvæ in 1913 was 23.432 days; in 1914, 21.082 days.

The time of leaving the fruit by the overwintering larvæ of the first brood was, during both seasons, a few days later than the time when the earliest transforming larvæ left the fruit. The period of leaving the fruit extended over a longer time in 1914 than in the preceding year. The average feeding period for the overwintering first-brood larvæ in 1913 was 27.884 days; in 1914, 29.348 days.

The pupation period of the first or summer brood covered practically the same time during 1913 and 1914, being slightly earlier in the latter year. The average length of the pupal stage in 1913 was 15.066 days; in 1914, 15.250 days.

The emergence of the first or summer brood of moths extended over approximately the same period during both seasons, being slightly earlier in 1913 than in the following year.

Oviposition by moths of the first or summer brood commenced about five days earlier and ceased about five days later in 1913 than in the following year.

The average life cycle of the first generation in 1913 was 51.566 days; in 1914, 51.416 days. Add four days for complete life cycle.

Hatching of the second-brood larvæ commenced about 12 days earlier in 1913 than in 1914. The average incubation period in 1913 was 11.862 days; in 1914, 10.208 days.

The second brood of larvæ left the fruit over a considerably longer period in 1913 than in the following year. This was due to the smaller number of individuals under observation in 1914 and to the warm weather conditions in November, 1913. The United States Weather Bureau (Climatological Service, North Atlantic States, November, 1913) reports that the "high temperatures caused unusual manifestations in nature." The average feeding period of the second-brood larvæ in 1913 was 49.160 days; in 1914, 42.750 days. The higher average in 1913 was due to the larger number of individuals which were leaving the fruit from September 25 to November 21.

THE CONTROL OF THE CODLING MOTH IN MAINE.

In connection with the life-history studies of the codling moth a series of spraying experiments was conducted in 1913 and 1914. As a result of these investigations it was found that one thorough spray application, as soon as the petals have fallen, is sufficient to control the codling moth. Arsenate of lead, paste 2 pounds or powder 1 pound to each 50 gallons of water, is recommended.

The proper time to spray is illustrated in Plate I. The spraying should be completed before the calyx cup closes too tightly, in order to fill each cup with the poison. This is of vital importance.

SUMMARY AND CONCLUSIONS.

The life-history studies of the codling moth herein recorded were conducted during the seasons of 1913 and 1914 at Winthrop, Me.

The codling moth in Maine has one full generation, a very small percentage (1 to 2 per cent) of the individuals of which transforms to make a partial second generation.

Pupation of the overwintering larvæ begins about the middle of May and extends to the first part of July. The length of the spring-brood pupal stage averaged 21 days.

The moths of the spring brood begin to emerge about two weeks after the petals have fallen and continue to issue for a period of about a month.

The average time from the date of emergence of the moths to first oviposition was about four days.

The oviposition of the spring-brood moths averaged 14 days.

The average length of life of the male spring-brood moth was about 12 days; of the female spring-brood moth about 13 days.

The earliest first-brood eggs were deposited approximately three weeks after the petals dropped.

The incubation period of the first-brood eggs averaged eight days.

The first-brood eggs began to hatch in from four to five weeks after the petals had fallen.

The transforming larvæ of the first brood fed for a period of about 22 days.

The overwintering larvæ of the first brood had an average feeding period of 28 days.

The female larvæ of the first brood fed for a longer period than the male.

The average time spent by the transforming larvæ in constructing their cocoons was about six days.

Approximately from 1 to 2 per cent of the first-brood larvæ transformed to first-brood pupæ. The remainder of the larvæ did not transform until the following spring (spring pupæ).

Pupation of the first or summer brood commenced during the latter part of July. The average length of the first-brood pupal stage was 15 days.

The first or summer brood of moths began to emerge just previous to mid-August and continued to issue for a period of about one month.

Oviposition by moths of the first brood began about mid-August.

The life cycle of the first generation was 51 days. The complete life cycle was about 55 days.

The average incubation period of the second brood of eggs was 11 days.

The average feeding period of the second-brood larvæ was 46 days.

The female larvæ of the second brood fed for a longer time than the male.

The hymenopterous parasite *Ascogaster carpocapsæ* Vier. was frequently reared.

The well-known beetle enemy *Tenebroides corticalis* Melsh. was commonly found attacking codling-moth larvæ.

The codling moth in Maine may be controlled with one spray thoroughly applied as soon as the petals drop. Arsenate of lead, paste 2 pounds or powder 1 pound to each 50 gallons of water, is recommended.

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